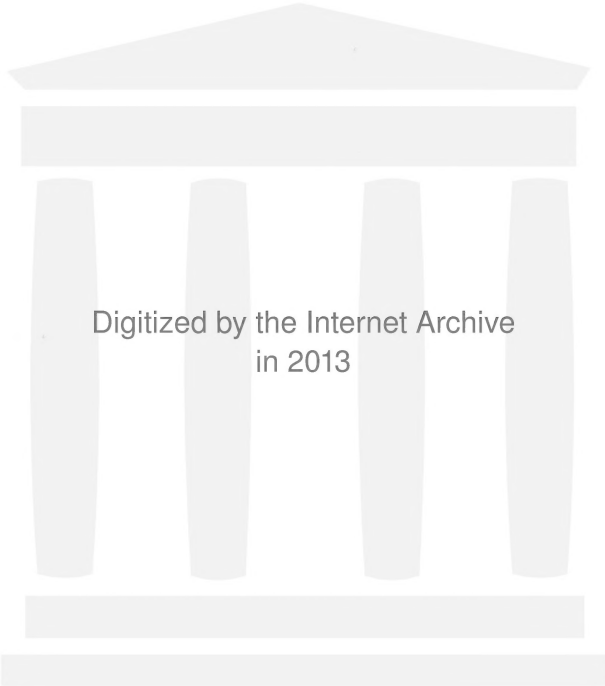


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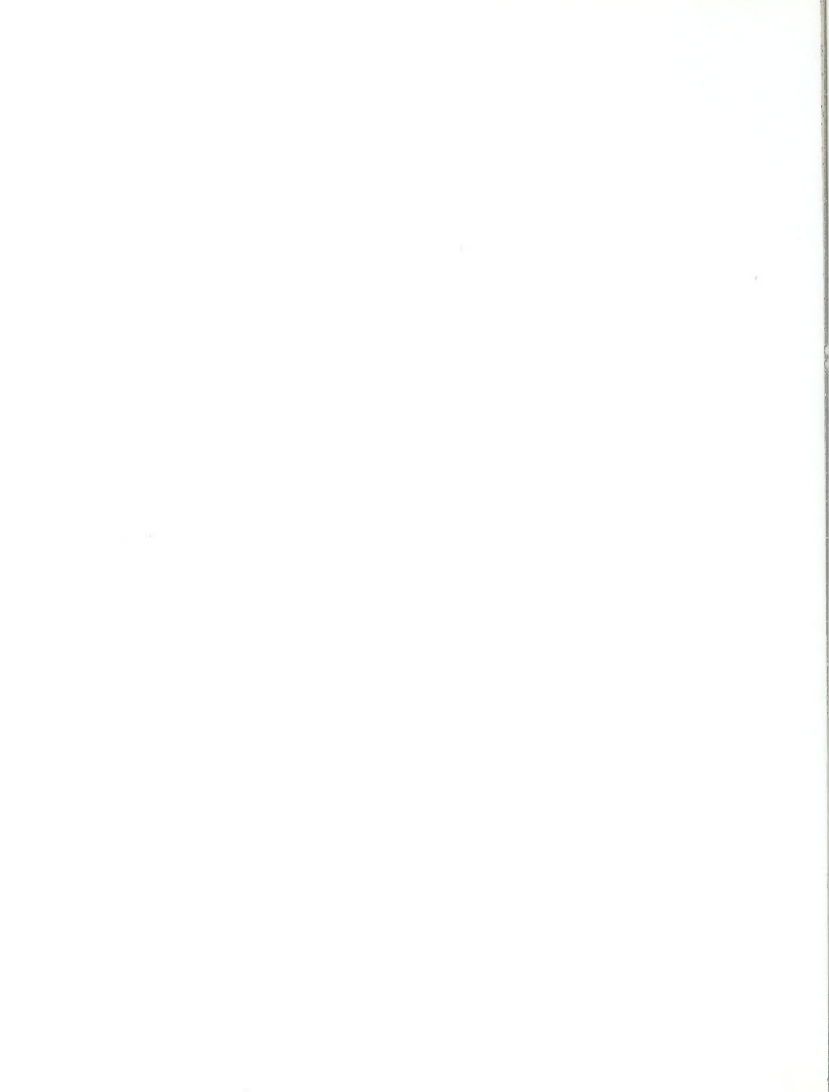
WILDLIFE ENCYCLOPEDIA

15





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VOLUME 15

◁ COVER PHOTOGRAPH

Puss moth. (Page 1832)

The caterpillar of the puss moth in its defense posture, showing its terrifying 'face.' The scarlet ring warns enemies that, if further molested, a burning formic acid solution will be squirted.

FRONTISPIECE ▷

Platypus. (Page 1755)

This strange animal sometimes called a duckbill, has a furry mammalian coat, webbed feet, and a duck-like bill. During the day the platypus rests in its burrow, coming out at night to forage for food in the mud of the river bottom.



FUNK & WAGNALLS **WILDLIFE** **ENCYCLOPEDIA**

GENERAL EDITORS • Dr. Maurice Burton and Robert Burton

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Pipistrelle

The pipistrelle or common bat, as it is called in Britain, is the most familiar as well as the smallest of European bats, although there are several other species of pipistrelle in continental Europe that are only slightly larger. It is recognisable by its jerky erratic flight and because it appears earlier in the evening than most other bats, sometimes coming out even in broad daylight. The jerky flight of pipistrelles gave rise to the ancient name for bats, which was flittermouse—German *Fledermaus*—and another medieval name for bats was *reremouse*.

Weighing only $\frac{1}{2}$ oz and with a maximum head and body length of 2 in., the pipistrelle is nevertheless of robust build, with short legs, broad flat head and a tail just over an inch long. The last joint of the tail is free of the interfemoral membrane joining the thighs, and is prehensile; the bat is thought to make use of this joint as a support when crawling up or down a vertical surface. The wingspan

is 8–9 in. The calcar, a spur on the hindleg, reaches almost to the tail and behind it is a lobe of membrane, the post-calcarial lobe, an important feature of identification.

Except on the ears and wing-membranes where it is blackish, the somewhat silky fur of the upperparts varies from dark to light reddish brown. The underparts are paler and the undersurface of the interfemoral membrane has no fur. The muzzle is blunt with a wide mouth, and the short, somewhat triangular, ears, slightly notched on their outer edges, end just behind the angle of the mouth.

There are about 40 species of pipistrelle. The range of the common pipistrelle includes the whole of the British Isles and continental Europe, southwest Asia north-eastwards to Korea and Japan and eastwards to Kashmir, and also Morocco. Other species live in Madagascar, the Malay Archipelago, Australia, the Philippines and North America.

The pipistrelle lives in a wide variety of places, singly or in colonies which may be small or may contain hundreds of bats.

It can be found, for instance, under roofs, behind drainpipes and gutters or in holes in woodwork and brickwork as well as in hollow trees and rock-crevices. Although the pipistrelle hibernates in the colder parts of its range, it is for a short period only: late October or November to March. A temperature rise of about 4–5 Centigrade degrees will awaken it and it will emerge from time to time for an hour's hunt for food. It may also move from one hibernaculum to another during winter.

Do my ears deceive me?

Hunting over a regular beat the pipistrelle flies at between 6 and 40 ft above the ground, uttering its shrill squeaks and capturing its prey on the wing. It feeds mainly on flies, particularly gnats, small beetles and other insects. It was once thought that the pipistrelle continued to hunt throughout the night, but it is more likely that it has periods of activity alternating with rest throughout the night, although it may not return to its roost until an hour or so before sunrise.

The bat uses its eyes to some small extent, but it relies mainly upon echo-location to find its way around and to capture prey. The



△ A resting pipistrelle bares its sharp teeth—good equipment for snapping up insects.
◁ Adult and young common pipistrelles sleep upside-down during the day, clinging on to a wall by their tiny claws.

frequent, ultrasonic squeaks bounce back from any solid object and, by interpreting the time taken for the echo to return, the bat is able to 'see' its surroundings. A bat probably carries a sound-picture of familiar territory, comparable to the visual memory of man. It appears, however, unable to assess size accurately. This is shown by the fact that a pebble tossed up into the path of a hunting pipistrelle will be followed down in an attempt at capture, although the pebble may be larger than the bat.

Delayed conception

Pipistrelles mate shortly before going into hibernation but fertilisation is delayed until the following spring. The single young is born between late June and mid-July after

Jim Beaman

Eric Hosking





So, it goes to the night. The common *Pipistrellus hesperus* (the so-called *Freight-bat*) is among the first bats to appear in the evening and live a *primarily nocturnal* life.

A gestation of 55-60 days. The American western *Pipistrellus* has two mating periods in late summer and early spring, but only one litter results, of 1-3 young, this being in June or July. The females of this species usually form maternal colonies and the young are nursed until ready for independence (B. L. B. Blackwell).

As in the European species, females of this American species are smaller than the males, which are 17 in. long, including a 1.5-in. tail, have a wingspan of 6 in. and weigh up to 1.5 oz. Their fur is yellow-brown above and paler below, with blackish long, thin, bristles. Their food is chiefly small beetles and flies, larger ones are caught in the pale, fennel-meatlike fat in their mouth. The American western *Pipistrellus* is similar in appearance and habits but is found scattered from the Rockies to the Pacific coast.

Drinking on the wing

Although *Pipistrellus* (a *micro* insect whose bodies contain 70% water) does not need to drink a lot (which often escapes the attention of those unacquainted in seeing bats anywhere near a pond level). Moreover, the *Pipistrellus* chosen for hibernation is often a cave or similar hiding place where the air is humid, sometimes so much so that their bodies become beaded with moisture. The damp atmosphere prevents them from becoming dehydrated. During the summer, however, when roosts under rocks (or, for example, are hot and dry) and they must drink. To get water, *Pipistrellus* use one of two methods. Either they land on the ground, for bats can scuffle like mice although more slowly in this skinier point of view, in the manner of shrews and marmosets dipping their lower jaw into the water while in flight. A *Pipistrellus* has been observed to do this several times in the course of a few minutes, swooping and manoeuvring over a pond, making use of the wind like a glider pilot.

Although it has been claimed that bats in swim, it is doubtful whether any of them, even the fish-eating bats of tropical America, deliberately take to the water. A strong argument against this claim is the number of bats found drowned annually in water tanks. From time to time *Pipistrellus* have been landed on water, have been seen to swim, then selves to shore, using their wing-like ears, and there are scattered reports of other small bats doing the same.

class	Mammalia
order	Chiroptera
family	Vespertilionidae
genus	<i>Pipistrellus</i>
& species	<i>P. hesperus</i> <i>P. pipistrellus</i> <i>P. subfuscus</i> <i>P. hesperus</i>

Pipit

The pipits are a group of more than 50 inconspicuous birds that, together with the wranglers, make up the family Motacillidae. To those who are not bird watchers pipits are just little brown birds, and if any

probably dismissed as sparrows. Although generally the same brown colour as the house sparrow, pipits have a more elaborate patterning of light and dark brown on the back, head and breast. Both in appearance and habits pipits are more like larks. They live on the ground and some sing in flight. They are small, slender birds, 6–7 in. long, with pointed wings and fairly long legs. The plumage of the different European species is so similar that it is very difficult to identify pipits in the field. Identification is usually only possible by a quality called the 'jizz' of a bird. This is a term used by bird-watchers to describe the individual collection of characters such as size and shape of the body, the proportions of different parts and the colouring that each species possesses.

Pipits are found on all six continents; one species *Anthus antarcticus* living on South Georgia, a large island lying within the Antarctic Convergence. Several pipits range over large areas of the northern hemisphere, some migrating as far south as southern Africa and Australia. The meadow pipit *A. pratensis* or *turdoides* is found in most of Europe except in the south, and spreads into northwestern Asia, Ireland and Greenland. The tree pipit *A. trivialis* extends from Europe across central Asia, and the rock pipit *A. spinoletta* is scattered through Europe, Asia and North America. Where it lives on rocks and stones it is called the rock pipit, but it is also found in mountain valleys, up to 12 000 ft in the Rockies, and here it is called the water pipit. The Bogota pipit *A. bogotensis* lives up to 14 000 ft in the Andes of Ecuador. The only other North American pipit is Sprague's pipit *A. spraguei* of the prairies. Six species live in South America and at least 11 in Africa. Some of the African species are brightly coloured. The yellow-breasted pipit *A. chloris* has yellow underparts and the golden pipit *Tmetothylacus tenellus* has yellow all over. Also living in Africa are eight species called longclaws. The yellow-throated longclaw *Macronyx capensis* is about 7 in. long and has an exceptionally long hindclaw of 2 in. The longclaws of other pipits are often long, but not as exaggerated as this.

Song flights

A tree pipit can often be seen perched right to the top of a tall tree, before it launches



Left: Tree pipit with finely patterned plumage. Right: Orange-throated longclaw *Macronyx capensis* with exceptionally long hindclaws.

into its song flight, flying up almost vertically. Just before it levels out it starts to sing, gliding down with its wings above its head and its tail spread. The song is more elaborate than that of the meadow or rock pipit. It consists of a single phrase of two to four notes, repeated several times and ends with a shrill trill. The soaring flight and repetitive song that carries well is very unlike, but compared with the skylark both the flight and song are very short. Pipits live mainly in open country such as grasslands, pampas, savannah and moorland, although some live in swamps, beside streams or along the shore. They run rather than hop, and a few species, such as the tree pipit, have the same tail pumping habit that is characteristic of wagtails. Some pipits perch on rocks and trees.

Insect eaters

Pipits are insectivorous, eating mainly grasshoppers, ants, mosquitoes and beetles that live on the ground or among the grass. Some slugs, spiders and a few small seeds are also eaten. Rock pipits feed on winkles and the remains of fish which they find along the shore.

Nests are built in depressions in the ground where they are often completely

hidden by grass. The favourite nesting sites are in the sides of banks, dells and cuttings. Grasses, bents, seaweed and similar material are woven into a cup among grass and herbage. The 3–7 eggs are incubated by the female for about 2 weeks. The male stays nearby, feeding the female and helping to feed the chicks, which leave the nest after just over a fortnight. Two broods are raised in one season.

Parallel evolution

The longclaws of Africa bear an amazing resemblance to the American meadowlarks – not true larks but relatives of mockingbirds and grackles. They are similar in appearance, and in habits. Their songs are similar and their nests are constructed in the same way. Furthermore, when approached they both turn away to hide their colourful underparts. This is a remarkable example of parallel evolution, in which two unrelated animals have evolved similar features and similar ways of life in response to the same type of environment.

Parallel evolution takes place when the two animals are separated geographically. If they lived in the same place they would compete for food and space. Conversely when two animals with very similar habits do live side by side, they are usually separated by the barriers of slightly differing habits, such as mating or feeding, or preferences for slightly different habitats. For example, one animal may prefer wet ground, the other dry ground. Such differences, perhaps trivial to us, are sufficient to prevent interbreeding. Many species of dunnock (p 623) live in similar habitats but do not interbreed. They are very difficult to tell apart and very similar species with slightly different habits are called sibling species. The meadow pipit and tree pipit are sibling species; they are superficially similar and breed in the same places, but in slightly different habitats. The tree pipit, for instance, starts its song flight from a tree, the meadow pipit from the ground.

class	Aves
order	Passeriformes
family	Motacillidae



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Piranha

Few accounts of travel in South and Central America fail to contain some references to the *piranha* or *peraya*, the small but allegedly very ferocious fish that inhabits the rivers of this region. In some places it abounds in such vast numbers as to be a serious pest, making the infested streams either very hazardous or quite impossible for fording or bathing.

The name *piranha* applies loosely to about 18 species, of which only 4 seem

to be dangerous to humans. All are members of the genus *Serrasalmus*, having a general similarity of appearance and habits. Some scientists, however, classify them differently. Most of the species average 8 in. in length but *Serrasalmus piraya*, of the River São Francisco in eastern Brazil, one of the most dangerous, may reach 2 ft. Most of them are olive-green or blue-black above and silvery or dark grey on flanks and belly. Some species have reddish or yellowish tinted fins. The colours seem to vary considerably from place to place and

with age. For example, old specimens of the white piranha *Serrasalmus rhombus*, found in the Amazon system and north-eastern South America, are often dark enough to be called black piranhas.

The body of the piranha is deep, short and rather compressed from side to side. A large bony crest on top of the skull supports a keel on the back, and a similar row of enlarged scales bearing sharp,

△ The gates of hell? A piranha displays its deadly teeth beneath its flaring nostrils.





backwardly-directed points; so the deep and heavy forepart of the fish is provided with a cut-water above and below. There is a fleshy adipose fin on the back between the dorsal and tail fins. The tail is slender and muscular and together with the broad, tough, blade-like tail fin helps to drive the body through the water with great force. As in all really swift fish the scales are very small. The most striking feature is the mouth. The massive lower jaw has relatively huge muscles operating it. The teeth are large, flat and triangular with very sharp points. These points merely pierce the skin, the rest is done by the edges, which are literally razor-sharp. The teeth of the upper jaw are similar but much smaller and fit exactly into the spaces between the points of the lower ones when the mouth is closed. The jaws are so strong and the teeth so sharp that they can chop out a piece of flesh as neatly as a razor. The fact that there is a reliable record of a 100lb capybara reduced to a skeleton in less than an hour shows the efficiency of the teeth.

A few of the smaller species are kept in aquaria, the most popular seen in tropical fish stores and public aquaria being *Serrasalminus nattereri*, the red or common piranha, up to 1 ft long and coloured red on the underside and fins.

Some piranhas are found only in certain river systems, such as the Rio São Francisco, Rio Paraguary or Rio Orinoco, while others range over a wider area.

◁ Piranhas take their pickings and leave. They never hunt in packs or groups and therefore they often make short work of a carcass.

Water alive with fish

Piranha hunt in shoals, sometimes of several thousands, so in places the water seems to be alive with them. Smaller fishes form their staple diet, but any animal entering or falling into the water accidentally may be attacked. They often attack each other. It is said that they will instantly be attracted by blood in the water but apparently anything out of the ordinary will attract them.

Waterplant hatcheries

It is thought that piranha breed when the rainy season sets in about January or February. The female deposits her eggs on water plants or roots. On hatching, the fry stay attached to the vegetation in clusters until they have absorbed most of the yolk sac, and then become free-swimming. *Serrasalminus spilopleura* is one of the few species which has been seen breeding in an aquarium. The female deposited her eggs carefully on aquatic plants, which is unlike the usual erratic spawning behaviour of most of the other members of its family. The male guards the eggs as well as the fry when they hatch. These became free-swimming about 5 days after hatching.

Ferocity exaggerated?

The ferocity of the piranha has become almost legendary. Stories are told of a cow or a pig, falling into a river, being stripped to a skeleton in a few minutes. One of the most famous stories is about a man, falling down and killed by a swarm of piranha. Later the bones of horse and rider were found, picked up by a man, the man's clothes undamaged. It is probable that a number of stories have been exaggerated. Some travellers now say that they have waded in or swam in rivers infested with piranha shoals and have never been attacked.



Marcelo G. Costa

Yet, every so often, they have come on villages where families, a native herd, not suffered the loss of a loved one. It is difficult to know what to believe, but there must be some truth in the danger from these fish.

It is possible that the ferocity of the piranha from a region with the species and from place to place, and it may be that they are much more aggressive at the beginning of the rainy season when the fish are guarding the eggs. This could also explain why it is that they will attack bathers at certain

places in a river, where perhaps they have laid eggs, leaving others unmolested not far away. Nevertheless, those aquarists who keep these fishes admit to treating them with respect and taking extra care in feeding them, or when netting them to transfer them from one aquarium to another.

Ca. No table manners. Piranhas have pointed teeth with very sharp edges, which bite out great chunks of meat from their victim.

?? Cleaned out. A carcass is left to the flies.

class	Pisces
order	Cypriniformes
family	Characidae
genus	<i>Serrasalmus nattereri</i>
& species	red or Natterer's piranha <i>S. piraya piraya</i> <i>S. rhombus</i> white or spotted piranha <i>S. spilopleura</i> common piranha others



Marcelo G. Costa



Pitta

Some of the pittas are among the most colourful birds in the world. The name pitta is a latinization of a native word meaning small bird. There are about 23 species, about the size of a thrush, with long legs, large feet and very short tails, giving them a very 'front heavy' appearance. They are also known as painted thrushes, ground thrushes and jewel thrushes because of their similarity to true thrushes. The plumage of pittas is immensely rich and varied, being made up of broad patches of colours including greens, reds, yellow and blues. The Indian, Bengal or blue-winged pitta is aptly known in India as the 'nine-coloured one'. It is about 7 in. long. The head is reddish-yellow with a thin black band over the top of the head and broad ones running through the eyes. The back and wings are mainly green, the rump and 'shoulders' pale blue. The chin and throat are white and the rest of the underparts reddish-yellow except for a scarlet patch under the tail. Perhaps the most beautiful pitta is Steere's pitta that lives in the mountain forests of the Philippines. It has a black head, white throat, sky blue, black, and scarlet underparts and a green and blue sheen on the back and wings.

Pittas live in forests, jungle or tropical scrub. Most live in southeast Asia, especially in the Malayan peninsula and archipelago, but some are found as far east as Japan and Australia, where the noisy pitta is known as the dragon bird because of its gaudy colours. There are also two species living in Africa.



Heard not seen

The brilliant colours of these birds are not noticed in the forests as they are secretive and shy and would be easily overlooked if it were not for their calls. These are loud two or three note whistles, trills or grunts. When one pitia calls, others answer it, the Indian pitia sets up choruses of whistlings, particularly at sunrise, and it is known as 'Ceylon's six o'clock bird'.

Pittas spend most of the time on the forest floor, hopping on their strong legs but they also ascend the trees to sing and roost. Some flick their tails continuously like a mouflon. Some pittas are migratory. The Indian pitta moves into Ceylon for the breeding season while those breeding in temperate regions such as Japan and Australia migrate to the tropics. The African pitta breeds from central Tanzania to South Africa but moves northwards in winter to Uganda. The tropical pittas have no migrations but probably move about in search of fresh feeding grounds.

«]. *Bronzed pitta*: *Pitta guajana*, L., *Green-breasted pitta*. *Pittas* tend to keep their feet on the ground, hopping around on their strong legs.

Ground feeders

Pittas forage very much like thrushes: they examine the ground with their beaks cocked to one side, hopping forward to catch an animal or feed. In leaves and on the ground, anything that is distributed. They feed on small animals that live on the ground, including earthworms, beetles, bees, crickets, and small lizards. Also like thrushes, many pittas feed on snails, carrying them to small stones or logs to smash open their shells.

Pugnacious pittas



Harry & Amanda French

outward, broadly, then a thin small circle back to the perch. The flight is accompanied by a buzzing noise which it probably made by the wings. When the Indian pitta sees a rival it flutters its wings and tail showing off its brilliant colour, especially the white patches on the wings that are normally hidden when it is perched on a branch.

They breed when food is most abundant, from February to April in tropical Asia, from November to February in Africa and Australia, and May to August in the northern part of the pitta range. The nest is an oval domed mass of moss and ferns. The entrance is in the side and leading to a short tunnel to the nest chamber which is lined with leaves and rootlets. The nest is usually in a bush near the ground but can be as high as 30 ft up a tree. The eggs are round and glossy, and in India and Malaya, a clutch of usually four eggs is laid with fewer in Australia and South Africa. Both parents take part in incubating the eggs and feeding the young.

Discriminating pitta

In general, the small birds of tropical Asia have not been well studied, but one green-breasted pitta received more than its share of attention from Tom Harrison, who has contributed so much to our knowledge of the wildlife of Malaysia. This pitta was kept in an aviary, where it became quite tame, while its food preferences were studied. It had a voracious appetite, eating more than its own weight of food every day. Its favourite food was earthworms followed by caterpillars, provided that they were not hairy, cockroaches and small grasshoppers. Other animals formed second choice, and were eaten only when the favourites had been consumed. These included spiders, wasps and large snails. Surprisingly a sap beetle and a tin can-pupae were comparatively consumed.

Observations such as these on the tastes of captive animals are instructive, especially when it is difficult to watch them feeding in

△ Proud snail smasher: The handsome *Pitta versicolor* feeds mainly on land snails.

the wild. It is particularly interesting to find why certain animals are not eaten by them, because they are too hard, too fast or poisonous, for instance. Even better, it is interesting to find that such animals as the centipede are eaten by the pitta. Experiments like this can be made on almost all pets, but it is worth remembering that individual animals, like people, have their fads, irrational though they may be.

class	Aves
order	Passeriformes
family	Pittidae
genus	<i>Pitta angolensis</i> African pitta
& species	<i>P. brachyura</i> Indian pitta
	<i>P. sordida</i> green-breasted pitta
	<i>P. steerii</i> Steer's pitta
	<i>P. versicolor</i> moss pitta

Pit viper

Some of the most-feared snakes are to be found among the 60 species of pit vipers (family *Crotalidae*) including well known forms like the fer-de-lance, which has already been dealt with (p 748) and the sidewinder and the rattlesnakes, which we shall come to later. Here we shall consider others, such as the American water moccasin, copperhead and bushmaster, as well as the Asiatic pit vipers.

Pit vipers are a diverse group with several interesting specializations, which is why we have given them three entries. Here, while dealing with the family in general terms, we pay special attention to what has been called their sixth sense, the two pits on the head that give them their name.

Pit vipers are saleglyph (see night adder, p 1568). That is, they have fangs which fold back and are erected when about to be used. Most are land-living, some are tree-dwellers, a few have taken to water and others lead a partially burrowing life. Water moccasins are heavy-bodied, up to 5 ft long, and while living on land they readily take to water when disturbed and they hunt in water. They are slate black to olive or tan with indistinct brown bands. The copperhead, a brown snake with hourglass markings along the back, is up to 3 ft long. It lives in rocky outcrops and quarries and among piles of rotting logs. The bushmaster is the longest of the American pit vipers, up to 12 ft, mainly grey and brown with large diamond blotches along the back. It has large venom glands and unusually long fangs. Its generic name *Lachesis* is from one of the Fates that influenced the length of life of people—a grim pun by the scientist who named it, for the bushmaster is one of the most dangerous of snakes.

The Asiatic pit vipers are of two kinds, tree-dwelling and ground-living, the first having prehensile tails that assist them climbing. The Himalayan pit viper lives at altitudes of 7 000–16 000 ft, sometimes being found even at the foot of glaciers.

The Asiatic pit vipers are found mainly in eastern and southeast Asia with one species extending as far west as the mouth of the River Volga. Wagler's pit viper is kept in large numbers in the Snake Temple in Penang. The water moccasin and the copperhead are widespread over the eastern and middle United States, the bushmaster ranges from Costa Rica and Panama to northern South America.

Warmblooded food

The warning posture of the water moccasin, mouth open showing its white lining, gives it the alternative name of cottonmouth. It also vibrates its tail at the same time, like its relatives the rattlesnakes, although it has no rattle to make a warning sound. Pit vipers, apart from their pits, are very



ordinary snakes. Some take a wide range of foods, like the water moccasin which eats rabbits, muskrats, ducks, fish, frogs, other snakes, birds' eggs, and nestlings. The copperhead eats small rodents, especially the woodmouse; other snakes, frogs, toads, and insects, including caterpillars and cicadas. The bushmaster, by contrast, takes mainly mammals, and pit vipers generally tend to hunt warm-blooded animals more than cold-blooded, as one would expect from snakes with heat detector pits. They have one on each side of the head between the eye and the nostril. Using these a pit viper can pick up the trail of a warm-blooded animal.

'Seeing' heat

Each pit is 2 cm across and 1 cm deep. A thin membrane is stretched near the bottom and temperature receptors, 500–1 500 per sq mm, are packed within this membrane. These receptors are so sensitive they can respond to changes as small as 0.002 of a C., and they allow a snake to locate objects 0.1 of a C. warmer or cooler than the surroundings. In more understandable terms a pit viper could detect the warmth of the human hand held a foot from its head. The membrane with its receptors can be compared to an eye with its retina. The overhanging lip of the pit casts 'heat shadows' onto it, so the snake is aware of direction, and since the 'fields of view' of the two pits overlap there is the equivalent of stereoscopic vision, giving a range-finder. A pit viper, hunting by day, has the advantage of being able to follow an animal's heat trail through low vegetation after the animal has passed out of sight. It could, of course, do this equally well by scent. The facial pits come into their own in night hunting, when prey can be tracked by scent with the facial pits guiding the final strike. At first it was thought they had something to do with an accessory aid to smell or as an organ of hearing, snakes have no ears. Another suggestion was that they might be organs for picking up low-frequency vibrations. Then, as late as 1892, it was noticed that a rattlesnake, one

△ Head first: *Trimeresurus gramineus*.

▷ Overleaf: Pit viper *Bothrops schlegelii*.

of the pit vipers, was attracted to a lighted match. Then came the discovery that pythons have pits on their lips that are sensitive to heat. The first experiments on pit vipers were made in 1937, and left no doubt that the pits are heat detectors and further studies since have shown just how delicate they are.

Snakes in cold climates

Pit vipers usually bear living young. There are a few exceptions, the bushmaster being one, and that lives in the tropics. Pit vipers extend from the Volga across Asia and across America. There may be a direct connection between these two things. One of the advantages of bearing living young, as against laying eggs, is that the offspring are protected not only against enemies but also against low temperatures until they are at an advanced stage of development. At some time pit vipers must have crossed the land bridge that used to exist where the Bering Straits are now. This is well north, and it would have been far easier for snakes able to bear live young to survive in these latitudes and so make the crossing. It probably explains also why the Himalayan pit viper can live so near glaciers, and why the most southerly of all snakes is a pit viper named *Bothrops ammodytoides*, living in the Santa Cruz province of Argentina.

class	Reptilia
order	Squamata
suborder	Serpentes
family	Crotalidae
genera	<i>Ancistradon</i> <i>contortrix</i> <i>copperhead</i>
& species	<i>A. himalayensis</i> <i>Himalayan pit viper</i> <i>Bothrops</i> <i>schlegelii</i> <i>Wagler's pit viper</i> <i>Trimeresurus</i> <i>wagleri</i> <i>Wagler's pit viper</i>





Plaice

The plaice is one of the best known of the

important. It has a flattened body, with the dorsal fin extending from the head almost to the tailfin, and the anal fin from behind the gill cover to the same point. The breastfin, upper, or right side is marked with red spots, each of which is surrounded by a white ring in the adult. These may be pale when the fish has been resting on whitish pebbles. The underside is purely white but can be partially or wholly coloured, a condition known as ambochromation. It may take the form of scattered brown or black spots or patches on the white undersurface. Alternatively, only the hindend may be completely coloured as on the upper surface, including the anal fin. When the plaice is at rest, it extends along the whole underside the undersurface of the head is usually white, but in exceptional cases even this may be coloured. The mouth is twisted, with the lower, or blind, side more developed and armed with a greater number of teeth. The small scales are embedded in the skin and there are bony knobs between the eyes. Plaice can grow to almost 7 ft long, but the usual size is much less.

They range from Iceland and the White Sea, along the coasts of Scandinavia, south through the North Sea to the coasts of France and the eastern Mediterranean. Plaice are not identical throughout their range, but an approximate number of races. There are numerous subspecies, but considerable differences exist in their degree of pigmentation.

Living magic carpet

Plaice live on sandy, gravelly or muddy bottoms, usually beneath mussels just off the bottom at low tide. In the day, and night, they are said to be dismissed on their magic carpet. This consists of a central anal fin and the flattened body. Like a magic carpet, they slide, flatten the body, push the anal fin over the bottom, and then, and then the fish is down and on its side, with its head and eyes to the bottom, and the rest of the body to the bottom. In this position, the plaice has a very effective pump action of the gills.

Young plaice seem to grow into a very similar habit of life in the sand. The young are present in shallow water, right down to the sand. At the appropriate time, they move from shallow to deep water.

Chisel and grinder

The teeth in the jaws of a plaice are of two kinds, the chisel teeth and the grinder teeth. The food is mainly small molluscs, but also small foraminifera, invertebrates, and worms are eaten. Plaice work over the bottom at high tide to feed on the cockle and mussel beds. They hunt by sight not raising the head much off the bottom, but shooting forward horizontally with great accuracy to take the prey. Very small molluscs are

taken whole into the stomach. Larger ones are crushed by the throat teeth. They also bite off the siphons of molluscs or the heads of worms sticking out of tubes.

Prolific spawnings

There is little in their outward appearance to tell male from female, but at spawning time if they are held up to the light the female roe shows as a small dark triangle. The male roe is a curved rounded line. The males reach the spawning grounds first and are still there after the females have gone. Spawning time differs from one part of the sea to another. Off the east coast of Scotland it is from early January to May, with a peak in March. In the Clyde estuary, on the west coast of Scotland, it is from February to June. In the southern North Sea it is from October to March.

To spawn, two plaice swim about 2 ft off the bottom, the female lying diagonally across the male, releasing a stream of eggs while he emits a stream of milt. Spawning lasts less than a minute, after which the two separate and return to the bottom. Each female lays 50-100 thousand eggs, the number depending, it seems, on the length



Plaice eggs with developing embryos

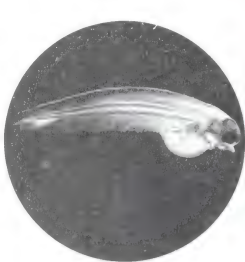
of the fish. The transparent eggs, each a two-capsule, are just under 1 mm diameter. They float at or near the surface, and many are eaten before they can hatch, which they do in 8-21 days according to the temperature of the water. The larvae are about 1 in long, without mouth or gills and with the remains of a yolk sac attached which supplies them with food. This is the most vulnerable part of the life of a plaice. Apart from those eaten by other animals only 1 in every 100 thousand survive the first few weeks of their life on 2-5 for every part of parent plaice. Although this seems disastrous, the figures are put in perspective by the knowledge that in one area alone, half a million to a million of the Haddock (the east of Haddock) 60 million plaice come together each year to spawn. The adults are probably protected by their colour and their habit of lying buried but seals find them, and predator fishes, such as cod, eat the molluscs.

Plaice are of great economic value but of the massed molluscs plaice eaten each year in Europe, few are eaten at the right

moment. Plaice has the best flavour when it is cooked immediately after being caught. The sole however, develops its characteristic taste 2-3 days after death due to the decomposition of the flesh with the formation of different chemical substances.

Baby food

As the contents of the yolk sac are being used up, the larval plaice starts to feed on diatoms. At this stage it has the normal fish larva shape, giving no indication of the adult shape to come. As it grows it graduates from small diatoms to larger diatoms then to larvae of small crustaceans, such as copepods, and molluscs. At this stage an important item is the planktonic food *Oikopleura*. After 2 months the larva gradually metamorphoses into a young flatfish, this takes about 25 weeks. The body becomes flattened from side to side, the young plaice starts swimming on its side, the skull becomes twisted by growing more quickly on one side than the other, causing the left eye to be swung over to the right side. At the same time the young plaice leaves the upper waters for the seabed, settling on its left side, so its right side and both eyes are



Larva lives in plankton, off its yolk sac.

uppermost. As these changes have been taking place the young plaice (still only 1 in long) has been carried by currents to its inshore nursery ground.

The account given above of the feeding of the larvae is only a generalization. The food taken varies in different places, the plaice taking whatever is available. In Scottish coastal waters they eat mainly worm larvae, crustacean eggs and larval molluscs. Off Plymouth, copepods and other small crustaceans are eaten. In the Irish Sea the larvae feed on small copepods, and spores of algae, and in southern North Sea it is mainly *Oikopleura*. The survival of the larvae can be seriously affected if supplies of these foods are low in a given area.

How they grow

After the 5 in. young plaice has settled on the bottom it reaches 2 1/2 in. by the age of 1 year, 5 in. by 2 years, nearly 8 in. by 3 years, 10 in. by 4 years and 13 in. by 5 years of age. These figures are for females, the males being smaller. On average, the males reach

Plains-wanderer

These unusual, and now rare, Australian birds, also called collared hemipodes, share with their relatives, the buttonquails, and with painted snipe and phalaropes, the unusual feature of having dominant females. The female plains-wanderer is 5 in. long, 1 in. longer than the male, and has brighter plumage. The plumage is not gaudy but has intricate patterns of reddish-brown, buff and black. The wings are short and rounded. At one time the plains-wanderer was classified with the buttonquails (p. 340) to which it is very similar in appearance, but it has certain

and pointed rather than oval eggs. Plains-wanderers live in southeastern Australia, from Lake Fraine in the west and as far north as central Queensland in the east. They seem to be most abundant in Victoria. They stick to the dry plains and grasslands, avoiding the scrub regions where the buttonquails live.

Reluctant fliers

Plains-wanderers are usually active at night and move about in pairs or family parties rather than in flocks like their relatives. They migrate in search of feeding grounds, flying with rapidly whirring wings. Usually, however, they are very unwilling to fly. If disturbed they run through the grass, occasionally rising on tiptoe to peer around, or freeze, crouching motionless, and it is sometimes possible to catch them by hand. The food of the plains-wanderer is mainly seeds of grass and other low plants, together with some insects.

Paterfamilias

The breeding habits of the plains-wanderer have not been studied in detail, but it is known that the female takes an active part in courtship and that the male incubates the eggs and guards the chicks. Whether the female mates with several males, as in buttonquails, is not known.

The nest is a grass-lined depression usually sheltered by tall grass or a bush. There are four eggs to a clutch, pale yellow or green with grey spots. The incubation period is not known but the chicks leave the nest shortly after hatching.

Causes of decline

The plains-wanderer is one of the growing number of animals that is becoming rare or extinct before their habits have been studied. In recent times some birds have become extinct before their eggs and incubation periods have been described. At one time the plains-wanderer was quite common and even now it is not so rare as to be put on the endangered list, but since Europeans settled in Australia its life has become more and more precarious. The grasslands have been transformed by agriculture; even stock farming drives out the plains-wanderer because sheep eat the seed-bearing plants on which it lives. Introduced rabbits, and fires, have had the same effect, and those that survive fall prey to foxes and feral cats.

class	Aves
order	Gruiformes
family	Pedionomidae
genus	
& species	<i>Pedionomus torquatus</i>

Plains-wanderers: the female has an orange bill



Platy

This is a small tropical fish, a longstanding favourite with aquarists who shortened its scientific name **Platy poecilus** to platy.

The scientific name has now been changed to **Xiphophorus** but platy still persists as the common name.

The wild platy is a deep-bodied freshwater fish of Mexico and Guatemala with a single dorsal fin and a relatively large, rounded tail fin. The males are up to 1½ in. long, the females up to 2½ in. The colour is brownish to dark olive on the back, the flanks being bluish and the underside whitish. The fins are almost transparent but in the male the pectoral fins are bluish at the tips and the anal and tail fins have a greenish-white band.

Platys have also been called moonfish, a name seldom used now, because of the mark at the base of the tail fin which looks like a crescent moon. This mark is, however, variable and is missing in many individuals, and the colours also are variable even in the wild forms, in which black checkered and red varieties are not uncommon.

A second species, from another part of Mexico, was named **Platy poecilus variatus**, or the variable platy, because of the range of colours it shows. It is similar to the first species and some experts treat the two as a single species.

Rainbow colours

Platys are sometimes described as cheery and not at all shy, which is just what an aquarist likes in his pets. They are easy to keep and they breed well, often producing colour varieties that can be selected and which breed true. They have, in fact, provided more colour varieties than probably any other aquarium fishes. Among these are the blue platys, in a wide range of blues, the red platys which at first were red, stippled with the black dots of the wild platy but are now bred in a pure deep red form, and the black platy which is green or yellow with a broad black stripe along the body, or may be all black except for the fins. Then a European aquarist found a yellow variety among his stock which became known as the golden platy, and when this was crossed with the wild form it gave the wagtail platy, which had a grey body and black fins at first, but later developed a yellow body and black fins. By breeding platys the aquarist was able to amuse himself with producing new colour varieties or even to study heredity.

Casual courtship

As well as eating animals such as water fleas and mosquito and midge larvae, platys take plant food and are especially fond of nibbling the green algae that grow on the sides of an aquarium. Courtship and mating are very brief. As the colours of the male intensify he either swims alongside the female or dashes about encircling her with outspread fins. Then suddenly they

mate, in one quick movement, while both partners are still moving forward. Fertilisation is internal and the babies are born alive, 10–75 at a time. The growth and general welfare of the young depends on the temperature of the water; for example they grow noticeably faster and survive better at 22°C/92°F than at 23°C/103°F.

In aquaria platys readily hybridize with the related swordtails, yet although these two fishes live almost side by side in their natural habitat they have not been known to hybridize there. Careful study of this suggests that courtship is not only a way of bringing the sexes into breeding condition, but is also a kind of language by which members of the species recognize each other and also learn to tell the difference between their own kind and members of another species. The courtship of the platys and swordtails is very similar differing only in a number of small details. None of these is important on its own but together they keep members of the different species apart. In an aquarium, where there is not the same wide choice of partners the 'language' breaks down and a male and a female of different species will come together and breed, giving rise to hybrids.

Cancer research

From one such hybridization came a significant discovery of medical importance. When a spotted platy was crossed with a green swordtail the offspring always developed cancerous growths along the sides of the body, remarkably like certain types of cancer in human beings. Here was an example of an heritable cancer—one that could be produced to order merely by crossing two kinds of fishes. This made it possible to study the genetics of cancer in a species that bred rapidly so giving quick results. Comparable studies on humans would prove long and difficult.

class	Pisces
order	Atheriniformes
family	Poeciliidae
genus	
& species	<i>Xiphophorus maculatus</i>

✓ No colours barred. Through selective breeding platys have probably provided more colour varieties than any other aquarium fish.





Platypus

Today the platypus is accepted as an unusual animal of quaint appearance, but it is not difficult to imagine its impact on the scientific world when it was first discovered. So strange did the creature appear that one scientist named it *paradoxus*, and a paradox it was with duck-like bill, furry mammalian coat and webbed feet.

Known as the duckbill, watermole or duckmole, the platypus is one of Australia's two egg-laying mammals, the other being the spiny anteater. The platypus is about 2 ft long including a 6in. beaver-like tail and weighs about 4½ lb, the males being slightly larger than the females. The 'bill' is a sensitive elongated snout and is soft, like doeskin, not horny as is popularly supposed.

Although bizarre in appearance, the platypus is well adapted to its semi-aquatic life. The legs are short with strong claws on the toes and the feet are webbed. The webbing on the forefeet extends well beyond the toes, but can be turned back when on land, leaving the claws free for walking and digging. The eye and the opening to the inner ear lie on each side of the head in a furrow which can be closed when the platypus submerges. There are no external ears, thus the platypus is blind and deaf when under water. Young have teeth, but these are replaced in the adult by horny ridges.

Thick loose skin makes the barrel-shaped body of the platypus appear larger than it is. The pelt consists of a dense woolly undercoat and long shiny guard hairs. The colour varies from sepia brown to almost black above and is silver, tinged with pink or yellow underneath; females can be identified by the more pronounced reddish tint of their fur. Adult males have hollow spurs, connected to venom glands, on the ankle of each hind limb. The poison from them can be quite harmful to a man, although not fatal.

The platypus was not discovered until 1796, nearly 200 years after the first wallaby, for instance, had been seen by a European. This is not as strange as might appear at first sight, for aquatic animals tend to be elusive particularly if, like the platypus, they are nocturnal.

Its range can be seen on the map. The western limits are the Leichhardt River in North Queensland, and the Murray, Onkaparinga and Glenelg rivers, just within the border of South Australia. It is found in all fresh water, from clear icy streams at 5 000 ft to lakes and warm coastal rivers.

▷ Platypus dives in a cloud of silvery bubbles. When underwater the platypus is blind and deaf so it relies mainly on its sense of touch. Highly developed in the soft rubbery bill.

◁ Out of its front door and into the river.





Australian Wildlife & Environment Bureau

Hearty appetite

Like some small mammals, platypus has a voracious appetite, and probably needs more food, relative to its weight, than any other mammal. It feeds mainly in the early morning and late evening, on crayfish, worms and other small soft animals. It probes for these with its bill and at the same time takes in mud and sand, which are apparently necessary for breaking up the food. During the day the platypus rests in burrows dug out of the banks, running one at night to forage for food in the mud of the river-bottom.

Egg-laying mammal

The breeding season is from August to November and mating takes place in the water, after an elaborate and unusual courtship. Among other manoeuvres the male will grasp the female's tail and the two will then swim slowly in circles. The female digs a narrow, slit-like burrow in a bank 25–35 ft, sometimes as much as 60 ft, long, 12–15 in. below the surface of the ground. At the end, a nesting chamber is excavated and lined with wet grass and leaves. The female carries these by wrapping her tail around a bundle. Usually two soft-shelled white eggs are laid, each $\frac{1}{2}$ in. diameter. They often stick together, which prevents them rolling, and the wet leaves and grass keep them from drying out. Before retiring to lay her eggs, 2 weeks after parting, the female blocks the tunnel at intervals with earth, up to 8 in. thick, which she rams into position with her tail. During the incubation period of 7–10 days she rarely leaves the nest but each time she does so these earth blocks are rebuilt. Presumably this is a defensive measure, but it has the effect the platypus has virtually no natural enemies, although a carpet snake or goanna may occasionally catch one. The inference is that in past ages natural enemies did exist in some numbers and the earth-block defences were very necessary. This is an example of what is known as 'fossil behaviour' and the platypus itself is a living fossil.

In the water the platypus uses its strong webbed forefeet for swimming and its hind legs as rudders. On land its forefeet are used for digging and to press the water out of its fur before it enters its burrow.



Use for spilt milk

The young platypus is naked and blind, and its eyes do not open for 11 weeks. It is weaned when nearly 4 months old, at which age it takes to the water. The mother has no teats; milk merely oozes through slits on her abdomen where it is lapped up by the babies. A platypus matures at about 2½ years and has a life span of 10 years or more.

Competing with rabbits

Formerly hunted ruthlessly for its beaver-like pelt, the platypus is now rigidly protected. Too often, however, it falls foul of water engines set under water for fish. Should the platypus enter one it cannot escape and will drown, as it is not able to stay under water for much more than 5 minutes. The introduced rabbit of Australia threatens the platypus in a different way. Where rabbits have driven too many tunnels the platypus cannot breed; it needs undisturbed soil for its breeding burrows. Fortunately, although reduced in numbers, it is now well protected by the Australian authorities and it is in no danger of extinction.

Creature of contrast

Fortunately for the sanity of naturalists, the paradoxical facts that the platypus, a mammal, laid eggs and suckled its young were not known when it was first discovered. In 1884, WH Caldwell, who had gone to Australia specially to study the platypus, dissected a female which had already laid one egg and was ready to lay another. Thrilled by this discovery he electrified members of the British Association for the Advancement of Science, then meeting in Montreal, with his laconic telegram – 'Monotremes oviparus, ovum meroblastic' (monotremes egg-laying, egg only partially divides). Delegates stood and cheered, for controversy over this point had raged in the scientific world for some years.

Long before this, in 1799, the first dried skin reached London and came into the hands of Dr Shaw, then assistant-keeper in the Natural History section of the British Museum. When Dr Shaw saw the skin he literally could not believe what he saw. At that time visitors to the Far East were bringing back fakes such as the 'eastern-mermaid', made from the skin of a monkey skillfully sewn to the tail of a fish. It is not surprising, therefore, that Dr Shaw should suspect someone had grafted the bill of a duck on to the body of a quadruped. He tried to prise off the bill, and today the marks of his scissors can still be seen on the original skin which is preserved in the British Museum (Natural History).

class	Mammalia
order	Monotremata
family	Ornithorhynchidae
genus	
& species	<i>Ornithorhynchus anatinus</i>

Plover

These pretty waders which can often be seen running rapidly along the foreshore, stopping for a moment and then running, are part of the large family of waders which includes the lapwings, dotterel and killdeer that have been treated separately. Attention is given here to the golden plovers *Pluvialis* and sand plovers *Charadrius*.

The four species of golden plover are distinguished by spangled black, gold or silver backs. Their underparts are usually black in the breeding season. At this time, the male golden plover, about 11 in. long, is spangled above and black below, with a white line separating the two that runs from

above the base of the bill, over the eye and follows the margin of the wing. The female is very similar. In winter the black disappears and the underparts become white with some mottling. The golden plover lives in Iceland, Faeroes, the British Isles, parts of northern Europe and northeastern Siberia. The closely related American golden plover is smaller, 9½ in. long, but otherwise is similar to the European golden plover. It breeds in the Arctic regions of Canada, Alaska and Siberia. The grey plover, known in North America as the black-bellied plover, also breeds in the Arctic, but also in Greenland or Scandinavia. The breeding plumage of the male is silver, rather than gold-spangled. The fourth species is the so-called dotterel of New Zealand which has

reddish-brown underparts.

The sand plovers are smaller, generally brown or grey above and white underneath with black bands across the breast and face. They include the ringed plover of northern Europe, together with the British Isles, northern Asia, Greenland, Iceland, Spitzbergen and parts of Arctic Canada. The little ringed plover is found over most of Europe, North Africa and Asia as far as Japan and New Guinea. The knot-tail or snowy plover breeds in North America, New Zealand, Europe, some parts of Africa, Asia and Australia. It no longer breeds in New Guinea. The most unusual of the plovers is the wrybill of New Zealand. It is the only bird with a bill that is bent sideways.

Spangled male golden plover stands in shallow water at low tide in a field of plover grass. The white line separates spangled top from black below.







Long migrations

Many plovers make long migrations to and from breeding grounds. One of the less spectacular is that of the wrybill, which breeds in South Island, New Zealand and winters in North Island. The American golden plover, however, travels from the high Arctic to Argentina and Australia and the grey plover, another Arctic breeder, winters in Chile, South Africa and Australia.

Plovers live on shores or very open country, usually near water, although the mountain plover of the dry plains of the southwest United States never lives near water. Outside the breeding season they gather in flocks to feed in estuaries, flying together with the precision often seen in

More than it can chew

Plovers eat mainly small animals such as insects, worms and small molluscs. Occasionally one tries to tackle too much, for ringed plovers and others have been found caught with their bills between the shells of cockles.

The wrybill uses its odd bill for probing (p. 116) stones in search of insects. On migration the American golden plover eats large numbers of grasshoppers and crickets. Berries are also eaten, especially by the American golden plover. It lives on the prairies and marshes when it arrives in the area during spring, before the insects have appeared.

Careful guardians

Plovers nest on the ground, without any lining. Many species regularly lay a clutch of 4 eggs but there may be as few as 2, as in the case of the American golden plover. Both parents incubate and tend the young, who leave the nest shortly after hatching. The incubating period ranges from 6 to 12 days in larger species and 4 to 6 days in smaller species. The chicks fly in 10 to 14 days.

Plovers are very inconspicuous when not in a nest and can often be found only by searching for the source of their whistling calls. The nests are also very difficult to find



Cockle shell nesting site: a Kentish plover about to settle on its mottled clutch.

and plovers regularly attempt to divert intruders by distraction displays in which they make themselves conspicuous. One display is the 'broken wing' in which one wing droops, showing up the white plumage underneath. In the 'rodent run' the plover runs with its tail drooping. The ringed plover, moreover, spreads its tail to show a conspicuous white border as it runs away from an intruder.

More about migrations

Usually if one is studying a bird's migration it is possible to go to one place to watch the movement both to and from the breeding grounds. If, however, one watched the American golden plover flying down through Labrador or New England it would

be no use coming back to see them return in the autumn, for they return by a different route. The golden plovers travel south from Arctic Canada and Alaska across Hudson's Bay to Newfoundland and New England, then across the sea to South America. In spring they return through Central America and up the interior of North America. There is a reason for this circular tour: the plovers are taking the shortest route that allows adequate food on the way. In the autumn they travel to the Atlantic coast to gorge on berries before setting off on their long sea journey to South America. The return trip would be impossible in spring because this area would still be foggy and frost-bound, offering no comfort to the plovers after a non-stop ocean flight. The interior of the continent however, warms up quickly in spring and food will already be available.

Another interesting migration is made by the ringed plover. It has recently colonised Greenland, Ellesmere Island and Baffin Island. These populations do not migrate to South America, but cross to Iceland then follow their ancestors' trail down through Britain into Europe and West Africa.

class	Aves
order	Charadriiformes
family	Charadriidae
genera & species	<i>Anarhynchus frontalis</i> wrybill <i>Charadrius alexandrinus</i> Kentish plover <i>C. dubius</i> little ringed plover <i>C. hiaticula</i> ringed plover <i>C. montanus</i> mountain plover <i>Pluvialis apricaria</i> golden plover <i>P. dominica</i> American golden plover <i>P. squatarola</i> grey plover <i>P. obscurus</i> New Zealand dotterel, others

☞ Overleaf: Flock of grey plovers take to flight.
▽ Distraction: a Kentish plover feigns a broken wing in an attempt to divert the photographer's attention from a well-camouflaged nest.





Van dancer, a long-legged plume moth, *Pterophorus pentadactylus* looks rather ghost-like with its feathery wings spread on its legs; wings twist by

Plume moth

The plume moths make up a comparatively small family whose wings are divided into 'feathers'. The forewings which are very long are divided into two or three parts and the hindwings into three or four parts. A few have wings without clefts, such as the European genus *Agdistis*. The bodies of plume moths are very long and slender, as are the legs which have prominent spurs. The wingspan ranges from $\frac{1}{2}$ –2 in. The flight is feeble and with their long body and legs, plume moths look rather like daddy-long-legs (p 601). When at rest the forewings are rolled around the hindwings and usually held straight out at right angles to the body.

There are about 600 species of plume moths, found in most parts of the world. Closely related are the feather-winged moths of the family *Orneodidae*, most of which are found in Asia. The many-plume moth, with $\frac{1}{2}$ in. wingspan, is found in Europe and the temperate parts of North America. The fore- and hindwings are divided into six and look like a pair of feather fans.

A watery death

During the day a sudden glimpse may be caught of a disturbed plume moth as it flies out of a plant in which it has been resting. Usually plume moths are active only in the evening or at night. They make themselves very inconspicuous when at rest among the herbage or hedgerows. Adults of *Agdistis* hold their rolled wings pointing forward in a line with the body, so they resemble the dried grass on which they rest. This camouflage is improved by their blackish

markings which look like moulds.

Plume moths live on a variety of food plants but are only occasionally pests. The grape-vine plume of the United States attacks the sprouting leaves of vines but is not as serious a pest as *Pachystatus atomaria* of India which burrows into pods and eats the growing peas. The pupa is later formed within the pod. The leaves and sometimes the flowers of a plant are the usual food of plume moth caterpillars. The caterpillars bore into the leaf and flower stems making them wither, or they bind the leaves into a rosette with silk strands so they are protected while they eat. The caterpillars of *Stenoptilia pinnosulcatus*, which feed on marsh gentians, are sometimes drowned by rain when they feed in the cup-shaped flowers. The caterpillars of *Agdistis baenckii* are liable to suffer the same fate. They feed and hibernate on the leaves of sea lavender, where they are in danger of being imitated by highlanders.

Mobile pupae

Eggs of plume moths are usually laid on the leaves of the food plants and the caterpillars feed on these leaves or flowers or bore into the stems and buds. There are often two generations in one year: the second hibernating as caterpillars in stems of the food plants. The pupa is soft and hairy and hangs from a leaf or stem like the chrysalises of some butterflies. Some species weave a cocoon that is no more than a few strands of silk thrown around the body. The caterpillars of the triangle-plume, which has black triangles on its forewings, hatch in June and feed on coltsfoot. The adults emerge and are on the wing from August to September then a second generation of caterpillars becomes active in September. They feed on the leaves of coltsfoot, before burrowing into the stems to hibernate. In the spring they feed on buds and flowers then pupate in the seed

heads, binding the seeds with silk so they do not fall. The adults emerge in May.

The pupa of *Leptoptilus longicauda* jerks sharply if disturbed, perhaps starting a predator. That of *Platystilia calodactyla* is also mobile. It often wriggles to the surface of its burrow in a leaf but retreats if disturbed. It is prevented from emerging too far by an anchor rope of silk attached to its hind end and the inside of the burrow.

Preying on the predator

Adults of *Leptoptilus palustris* can sometimes be seen during the day, flying over boggy heaths and moors. They lay their eggs on sundew, a peculiar bog plant that captures and devours insects. This habit is found in other bog plants and is probably related to the deficiency of nitrate in boggy soils. The deficiency is made up by breaking down protein in the insects' bodies. The upper surfaces of sundew leaves bear hairs segmented by glands. When an insect lands on a leaf it is trapped in sticky secretions, the hairs of the plant bend towards it and secrete fluids that digest it. The products of digestion are then absorbed by the plant. The caterpillars of *Leptoptilus* feed on sundew leaves and presumably in some way avoid being caught and digested, but it seems to be as precarious a way of life as living on manure-dropping flies.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Pterophoridae
genera & species	<i>Orneodes hexadactyla</i> <i>many-plume moth</i> <i>Oxyptilus periselictadactylus</i> <i>grapevine plume moth</i> <i>Platystilia gonodactyla</i> <i>triangle plume moth</i> , others

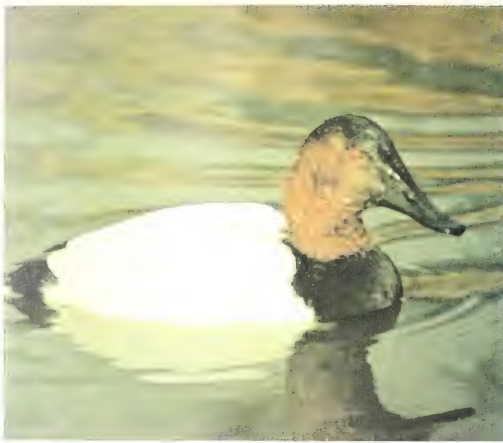
Pochard

Pochards dive for their food, like grebes, with a quick hump up before plunging under. Thus they are more adapted to an aquatic life than their dabbling relatives, the mallard and pintail. Their legs are placed well back on the body and most pochards have difficulty in walking. They

roosting. The short, heavy body has a large head and long neck. The males have an eclipse plumage when they live in the temperate zone. The three pochards in the genus *Netta* are less adapted to an aquatic life and do not dive as well as the other species. They float higher in the water and walk more easily. The other 11 pochards are divided in the genus *Aythya*, of which there are four groups. The first

and the American canvasback and redhead. These are similar in plumage and important game birds. The second group is made up of pochards called white-eyes; the third group of pochards are mostly black and white, including the tufted duck and New Zealand scaup. The fourth group includes the tree swamps.

The most important pochard is the canvasback that breeds in western North America from Alaska to New Mexico and migrates down the flyways (see pintail p. 1769) as far as South America. Even if it is not the most shot-at of ducks it is the most esteemed for eating. Most of the body



By: A. Harrell & R. D. Dyer

is famous North American spoon-billed duck, the canvasback, identified by reddish-brown head. The European tufted duck, the black and white canvasback here has a thin drooping crest, the female a broader and has a rudimentary crest. The Redhead, *Netta peposaca*, like the other two of its genus, is a non-diving pochard

is light grey with black on the breast, and a russet head and neck. A closely related pochard is 18 in. long and breeds in Europe and central Asia. The plumage of the two species is almost identical. Next in importance to these two is the redhead or American pochard. The tufted duck, 17 in. long, is an Old World bird, ranging from Iceland to Kamchatka. It is all black with very distinctive white flanks and a small trailing crest. The scaup duck, with a circumpolar Arctic distribution, has a plumage similar to the tufted ducks, but lacks the tuft and has a light grey back.

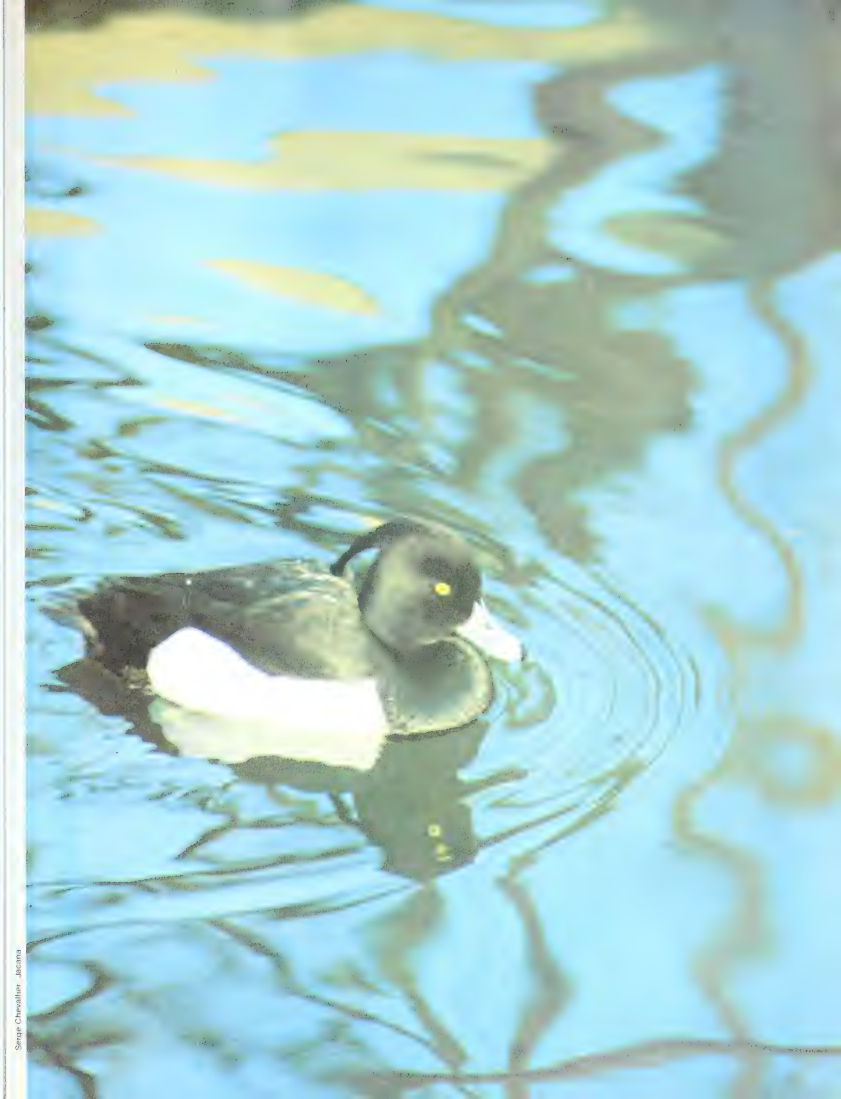
Most pochards live in the northern hemisphere but in the south there are the southern pochard from Abyssinia to South Africa, the New Zealand scaup and the Australian white-eye, which colonised New Zealand but later died out.

Commuting to feed

Pochards migrate in V-formation; sometimes the whole flock plunges spectacularly from a great height towards a sheet of water. Their habits are in general similar to those of dabbling ducks. Pochards breed in freshwater and some spend the winter in salt water or the brackish water of estuaries where they can be found in large flocks. Others only go to sea during very cold weather. There may be an excess of males in the flocks, as much as 50 to 1. They feed mainly in the morning and evening and sometimes at night. Shallower waters are preferred for feeding and in the evening there is a 'light' from larger, and safer, waters to smaller pools. Pochards are awkward when they take off or land, as they have to run over the water before gaining sufficient lift with their short wings.



By: A. Harrell & R. D. Dyer



Tasty duck and celery

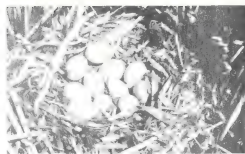
Pochards feed on aquatic plants and animals, usually diving to collect them from the bottom. They eat sticks, roots, animal plant food and for this reason its flesh tastes better than that of the European pochard which eats mainly small animals such as insects, molluscs, worms, small frogs and a few fish. About three-quarters of the

population feeds on water-lilies and wild onions. The best tasting canvassacks are those that have fed on the 'wild celery' that grows around Chesapeake Bay. This has long ribbonlike leaves and grows just offshore in great quantities. The canvassacks prefer the roots which taste like garden celery. They dive to uproot the plants and bite off the roots, leaving the rest to float away. Redhead and scaup also dive for water celery roots, but other ducks, such as the baldpate or American wigeon

do not. The European pochard and American wigeon are also known to eat the roots of the water celery. The European pochard and American wigeon are also known to eat the roots of the water celery. The European pochard and American wigeon are also known to eat the roots of the water celery.

Cuckoo duck

Pochards nest in marshes or lakes and ponds. The nests are often quite close together and are usually very near water. Canvassacks and European pochards often nest among reeds in the water, raising the nest above the water level with a pile of dead reeds and other plants. The redhead sometimes lays its eggs in the nest of another duck, cuckoo-like, and the winged grebe does this before the chicks are hatched, although the male usually leaves the nest before the chicks are hatched. The male usually leaves the nest before the chicks are hatched.



Red-crested pochard nest. The nest is covered by the parents, hiding the eggs from predators and conserving some heat. This behaviour is common to ducks and some grebe species.

soon as they are dry, and guarded and fed by the female, who brings food to the surface for them before they have learnt to dive. The canvassack abandons her brood early and these broods hang together, forming groups of first-year ducks.

Making ducks precocious

The story of an animal's behaviour is often made by presenting a test animal with the different situations that it would normally meet when doing, feeding, courting, fighting and so on. From this the stimuli eliciting various forms of behaviour can be determined. A well-known example of this is the male common kingbird's bunch of red feathers, from which we learn that it is by the red

breast that a robin recognises a rival. But the response to stimuli often varies and depends on other factors, such as the internal state of the animal. It has been found that some behaviour is controlled by hormones within the body (see phalarope p 1741). When the testes and ovaries are not functioning sexual and aggressive behaviour are usually absent. Such behaviour can be stimulated by the injection of sex hormones and it has been found that the chicks of many birds may perform courtship displays when treated with these hormones. The male downy chicks of redheads start to perform courtship displays and calls after treatment with testosterone, the male sex hormone, as do male chicks of mallard and pintails. The displays given are, however, only those that appear in the adult 'spontaneously'. That is, they may be given when the male is not specifically courting. The treated chicks did not give displays that required the presence of a mate. This shows that courtship displays, like other forms of behaviour, are sometimes dependent only on the state of the animal, but at other times the animal also needs external signs or stimuli to trigger off the behaviour.

class	Aves
order	Anseriformes
family	Anatidae
genera & species	<i>Aythya americana</i> redhead <i>A. australis</i> Australian white-eye <i>A. ferina</i> European pochard <i>A. fuligula</i> tufted duck <i>A. marila</i> scaup <i>A. novae-zealandiae</i> New Zealand scaup <i>A. valisineria</i> canvassack <i>Netta erythrophthalma</i> southern pochard, others.

Female flock of scaup-ducklings tended by a female. The breeding grounds of this hardy duck are often within the Arctic circle.







Polar bear

The polar bear is one of the largest and the most carnivorous of all bears. The males average 7–8 ft long and may reach 9 ft with a height of 5 ft at the shoulder. The average weight is 900 lb and the maximum over half a ton. The females are smaller, with an average weight of 700 lb. Polar bears have a long head with small

ears, and a 'Roman' nose, a long neck, powerful limbs, broad feet with hairy soles, and a mere stump of a tail. Their coat, white with a yellowish tinge, is made up of long guard hairs and a dense underfur.

Their home is along the southern edge of the Arctic pack ice. Although they can swim strongly, they avoid stretches of open water and fast ice. They are carried southwards by the ice in spring and summer and return northwards when the ice breaks up.



◁ Overleaf: Queen of the castle. A polar bear isolated with her cubs keeps an eye open for intruders on the pack ice of the Arctic. The cubs remain with the mother until they are about two years old, and sometimes are allowed to cling to her as she swims along.

▷ A solitary polar bear steps carefully over the rocks of the Arctic. Polar bears are mammals and swim for miles in search of food.

▽ A happy family—two cuddly cubs satisfy their hunger. Polar bear cubs stay with their mother until she is ready to mate again.



A home of ice and water

Polar bears are expert divers and swim strongly, at about 6 mph, using only the front legs, and trailing the hindlegs. A thick layer of fat under the skin, 3 in. thick on the haunches, helps to keep them buoyant. Polar bears have been seen swimming strongly 200 miles from land. They usually swim with the head stretched forward, but when the sea is rough they put their heads underwater, lifting them periodically to breathe. The fat layer keeps out the cold. When it comes onto land the polar bear shakes itself like a dog.

Polar bears can walk easily over ice because of their hairy soles, and when pursued can run at speeds of up to 18 mph. They swing their heads from side to side as they walk, as if searching or smelling out prey. Essentially nomadic, they wander for miles in search of food.

Preying on seals

Their favourite food is seals, especially the ringed seal, which the bears stalk by taking advantage of snow hummocks. A seal asleep on the edge of the ice falls easy prey. The polar bear swims underwater to the spot, comes up beneath the seal and crushes its skull with one blow of the powerful forepaw. When a ringed seal is about to pup she digs an igloo in a hummock of snow over her breathing hole. Polar bears sniff out the gloos and take the pups. They are said also to hold down a pup with one paw so that its struggles attract the mother within reach of the bear. They will kill young walrus, but in a fight with a grown walrus the bear is likely to come off second best. The bears also eat fish, seabirds—at times their eggs, too—and carrion. A stranded whale will draw bears from a large area. Such a carcass once attracted 24 bears. At certain times of the year, usually in late spring or early summer, polar bears will eat large quantities of grass, lichens, seaweed, moss and other plants, and are fond of crowberries, bilberries and raspberries.

Cubs driven away

Mating is in April or May and after a gestation of 240 days usually 2 cubs are born in December and January. At birth each cub is a foot long and weighs 1½ lb. It has a coat of short sparse hair. The eyes open at 33 days, the ears at 26 days, although hearing is imperfect until the cub is 69 days old. It starts to walk at about 47 days and is not weaned for 3 months. The cubs stay with the mother until they are at least 10 months old, often longer. When she is ready to mate again, she drives away any remaining cubs, which are by then 200–400 lb weight. Polar bears are sexually mature at 2½–5 years, the females maturing later than the males. Most of this detailed information, which would be difficult to collect in the wild, has come from records of successful breedings in zoos where some polar bears have lived well. Since polar bears are now being rapidly exterminated to satisfy the taste of the affluent for luxurious rugs it is as well that zoos have mastered the art of breeding these fierce but beautiful beasts.

No hibernation

It is often said that cubs are born while the mother is hibernating. Polar bears, like



other bears, do not hibernate in the strict sense and it is now usual to speak of their sleep as winter dormancy. The pregnant she-bear seeks out a bank of snow in the lee of a hill and digs into it. There is difference of opinion as to whether the males 'hibernate'. It seems likely that some do, but for shorter periods than the females.

Man the enemy

Apart from man the polar bear has no enemy. It is the only animal that has gone it in self-defence. Young bears die of accidents, by being drowned or crushed by the ice, or by being killed by old bears eat the cubs, given the opportunity. Polar bears have long been hunted by the Eskimos and other Arctic peoples. Their long canine teeth, too, are used for ornaments. Bed covers, sledge robes and trousers are made from the pelt. Although Eskimos eat the flesh the liver is not used, not even to feed the dogs. Its poisonous quality is said

to be due to the high concentrations of vitamin A, which causes headaches and nausea, and sometimes a form of dermatitis.

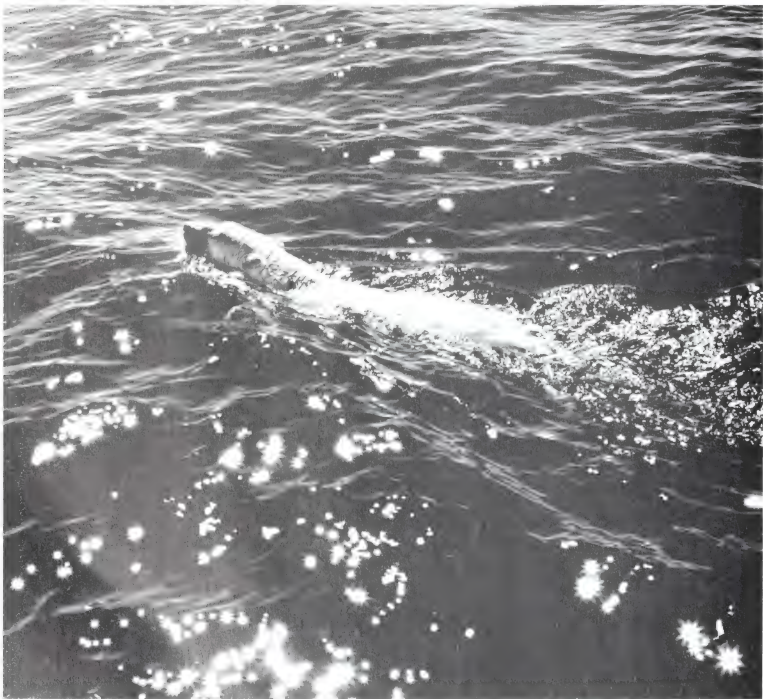
Conserving the bear

CR Harrington, writing in *Canadian Audubon*, tells us that the earliest known record of polar bears taken into captivity was for 880 AD, when two cubs were taken from Iceland to Norway. 'At that time the animals were commonly offered to European rulers, who rewarded the donors on various occasions with ships carrying cargoes of timber or even bishoprics.' Intensive hunting of the bear began in the 17th century when whalers reached the pack ice. Two centuries later polar bears were decreasing in many parts of the Arctic. Then came the turn of the sealers, and in 1942 alone Norwegian sealers killed 714. More recently the Eskimos have been hunting the bears not for their own use but to trade the pelts. In parts of arctic

North America it is easy to land by aeroplane and shoot the bears for sport, but legislation controlling this is under fairly constant review. In 1965 Harrington estimated the world population at over 10 000 with a total annual kill of about 1300. In September of that year an international conference decided that each nation taking part should make a study of polar bears in its territory. The results of these studies have not yet been published but will include information on the life-history, ecology, seasonal movements and population changes.

class	Mammalia
order	Carnivora
family	Ursidae
genus	
& species	<i>Thalarctos maritimus</i>

FIG. 1. Polar bears are the only large land animals that can swim. A polar bear hawses the cold waters of the Arctic where it may swim for miles out to sea.





Portrait of a polecat in its typical station: long, slightly elongated body slung low, long neck stretched out and an assertive expression.

Polecat

The unpleasant discharge from its glands gave the polecat, or fitcher, its former English name of foumart or foul-marten. Because of this its fur, sold under the name 'fitch', is considered by some to be useless, but it was widely used in the early 19th century and is still used to a slight extent today.

The male polecat is about 20 in. long, of which about 5½ in. is bushy tail, and weighs up to 3 lb. The female is slightly smaller and only a little over half the weight. In both sexes the long coarse fur is dark brown on the upper parts with dense yellowish underfur showing through, and black on the underparts. The short legs and tail are black, as is the head, which has white or yellow patches between the small ears and eyes from June to November. These tend to join over the eyes in winter and, rarely, to join up with a chin patch. In a limited area of Cardiganshire, in Wales, a 'red' variety of polecat sometimes occurs, in which the coat is red, ginger or fox-coloured.

The polecat is still common throughout Europe as far north as southern Sweden and southern Finland. In the British Isles, however, it has become very rare except in Wales. Indeed, in mid-Wales, its numbers seem to be increasing.

Snake-in-the-grass

The polecat's long, almost cylindrical body moves at speed as it slinks across bare ground or close-cropped grass, with its body slung so low that it seems to be touching the ground. The long neck is stretched out and the short legs move almost in a paddling action, so the animal seems to glide rather than run. Seen from the side, the action of the limbs is more reminiscent of swimming than of running.

Taken young, polecats are easily tamed, and give little sign of their traditional

smell, probably because this is used in the wild to mark a territory, not, as was formerly thought, as a defence. They also deposit urine and faeces along their trails to mark them. They spend a lot of time playing together, they will mumble over each other in a bunch, endlessly wrestling or romping in a mass of supple bodies. A significant part of this is that they grip each other by the back of the neck. Thus, it seems, is how they develop the neck bite used to kill their prey.

Versatile predator

A remarkable feature of the polecat is the great variety of habitats in which it can flourish. It is found in Wales from the coast right up into the hills, and as far afield as home among sand dunes and on sea cliffs as it is about lowland farms or wooded gorges. It prefers, however, woods and copests, making its den in any suitable hole, such as a fox earth, rabbit burrow or natural rock crevice. A wood-stack has sometimes been used. With the approach of winter, polecats may seek shelter in deserted buildings. They are less agile than martens, and cannot climb as well as they do. They are active mainly at night, depending on a keen sense of smell to hunt down prey. They are usually silent but occasionally use short yelps, clicks and chattering. They also scream and hiss when frightened, as part of a 'defensive threat'.

Kittens in the larder

The polecat feeds on rats, mice and rabbits, birds and their eggs, frogs, lizards and snakes. It is said to kill vipers and to be immune to their poison. The bodies of three kittens, known to have been drowned at about a quarter of a mile away, were once found in the larder of a polecat bitch. The usual method of carrying smaller prey is to grip it by the middle of the back, much as a retriever carries a game.

It is usual, when speaking of polecats or any other small carnivore, to stress that they are adept at getting into hen-houses and that they have been known to kill all the occupants instead of just taking one. Indeed, the name is said to be from the French, *poule chat*, the chicken cat. Accusations of

poultry-killing may be justified to some extent. J.G. Wood, writing in 1892, said that the polecat was common in every part of England, but he also described it as dreadfully destructive to the poultry. He tells of somebody's dog digging out a polecat from its burrow and bringing out a whole brood of ducklings, previously lost by a farmer. Predators like the polecat, however, may help keep the populations of small mammals, especially rats and mice, within bounds. The wholesale reduction in the numbers of polecats might have contributed in the past to the calamitous increase in the populations of rats.

One litter only?

The polecat mates in early spring, probably in April, and the gestation period is about 6 weeks. Litters of 3–8, usually 5–6, are born in a nest of dry grass in woods or among rocks. The babies are blind for their first fortnight and are pure white, the colours and markings of the adults, appearing at about 3 months. It has been said that there is probably a second litter a few months later. This is unlikely since the young do not leave their parents until 3 months old, which would pass the time of a second litter to late summer or early autumn. Baby polecats huddle in the nest to keep warm, but in hot weather lie as far from each other as possible. A female polecat in captivity was seen to wet her belly in her water dish then curl herself around the babies to cool them. Another seemed to be teaching her babies to hunt. She would carry meat into the nest then drag it out, leaving a scent trail for them to follow to reach it. Whether this happens in the wild is not known.

Rapid extermination

According to L. Harrison Matthews in *British Mammals*, the polecat was formerly a very common animal even close to London up to about a hundred years ago, whose rapid extermination over most of the country began with the first use of gin traps. At the beginning of the 19th century it was still widely distributed throughout



England, Wales and Scotland, and records show that a total of 400 polecat pelts were sold at the old Fair Fair at Dumfries, in Scotland in 1829, and 600 in 1831. In 1866, however, the number of furs for sale at the fair was only six, after which they ceased to be included in the records. In parts of the Highlands the polecat survived longer and in Argyllshire was not uncommon about 1880. In the counties of Inverness, Ross and Sutherland it even survived into the present century but soon after 1907 the Scottish polecats seem to have become extinct and there has been no authentic record there in the past 50 years.

In England the polecat seems to have survived for as long or longer than in Scotland. Early this century it still lingered from Surrey westward to Cornwall, in woods in Lincolnshire, in several of the central counties, and in Cumberland.

Many years ago polecat-hunting was practised among the country squires of North Wales, Cheshire, Cumberland and Westmorland, where packs of hounds were kept specially for this.

class	Mammalia
order	Carnivora
family	Mustelidae
genus & species	<i>Mustela eversmanni</i> <i>Asiatic polecat</i> <i>M. putorius</i> <i>Vormela peregusna</i> <i>marbled polecat</i>

▽ *Pigeon pie?* Three young polecats tuck into a pigeon, savagely tearing it apart. They also enjoy duck and poultry, to the dismay of many a farmer, although they are good ratlers.



Pollack

The pollack is probably the most handsomely coloured member of the cod family. It can be recognized especially by the jutting lower jaw and the lack of a barbel on the chin. Otherwise its shape conforms to the typical cod pattern, with three dorsal and two anal fins, small pectoral fins, and very small pelvic fins lying under the throat. It is dark green on the back, shading to light green on the sides, which are streaked and spotted with yellow. The belly is white. The fins are dark yellowish green and the eye golden. The lateral line is dark and strongly curved over the pectoral fin. Pollack are up to 2 ft long, exceptionally 2½ ft, and the line-

caught record is 23½ lb. They range from Norway to the Mediterranean.

The origins of the name are unknown, and it has been variously altered in the past to pollock, podluk and podley. The first of these names was taken to North America and given to the coalfish, (p 458) the pollack's nearest relative.

Midwater feeders

Pollack are more a coastal fish than any other member of the cod family. They are often taken by line fishermen from the shore and when hooked they dive powerfully for refuge among the rocks. The pollack is not highly esteemed for its flesh, although it is regarded as a good sport fish. It is plentiful especially off Scotland where it is known as the lythe. Pollack come to the surface at night and are readily attracted by lights.

Mackerel fishers often catch them with bright, moving baits. Their preference for moving bait gives a clue to their food. They feed in midwater on small fish, especially sand eels, sprats, herring and pilchard. They rarely stoop to feed on the bottom, on worms, crustaceans and molluscs.

Junior marathons

Pollack spawn from February to May. The small, widely separated spawning grounds are in depths of 300 ft or less. Because the spawning grounds are so scattered—as far apart as the western English Channel and the Hebrides—young pollack make long migrations as they spread out around the coasts. The eggs, ⅓ in. diameter, float near the surface. The young fish feed on the seabed, on crustaceans, worms and molluscs.

Delusory armour

Many people regard scales as a protection, so it is worth noting a remark by Dr Douglas Wilson in his *Life of the Shore and Shallow Seas*. He points out that when catching pollack for the aquarium it is better to use hooks than a net and not to hold the fish in the hand when removing the hook: 'a torn jaw nearly always heals but a few lost scales generally end in death'. Shore fishes, more liable to be thrown about by waves, do not easily bruise. They usually have no scales or only tiny ones embedded in, or else firmly fixed to, the skin.

class	Pisces
order	Gadiformes
family	Gadidae
genus & species	<i>Pollachius (Gadus) pollachius</i>

- △ The lateral line and tiny scales of pollack.
▽ Pollack, the most handsome member of the cod family swimming with bib *Trisopterus luscus*.



John Burton. Photo Film



John Burton. Photo Film



Pompadour fish

This fish from the rivers of the Amazon basin has been described as the noblest among aquarium fishes. Its name of pompadour is then quite appropriate although it is also known as the discus from its shape. The pompadour fish and its relative, which is divided into subspecies known as the green discus, brown discus and blue discus, are almost disc-shaped when fully grown and up to 8 in. long. The long dorsal and anal fins make the otherwise oval body look more nearly circular. The body is covered with small scales but the cheeks and gill covers are more markedly scaly. The mouth is small, with thick lips. There is a single row of small conical teeth in the middle of each jaw and

instead of the usual two pairs, there is a single pair of nostrils.

The colours are not easy to describe because they change with age. A young pompadour fish is known with several vertical dark bars down each side. At 6 months old, flecks of blue appear on the head and gill covers, and these spread until the sides are coloured with alternating bands of blue and reddish brown and there are nine vertical dark bands, the first running through the eye. The fins become blue at their bases, pale blue and orange on the outer edges, and there are streaks of blue and orange between. The pelvic fins are red with orange tips. The green discus is mainly green with 9 dark vertical bars, the brown discus mainly brown with 9 dark bars and the blue discus brown with 9 blue bars.

△ Turning blue with age, pompadour fish *Symphysodon aequifasciata*. At 6 months the head and gill covers become flecked with blue and this gradually spreads across the sides.

Hanging by a thread

Pompadour fishes usually spend the day sheltering in the shadows of water plants when they are not feeding and they avoid strong sunlight. They eat water insects, especially the larvae of midges and small dragonflies, small worms and similar invertebrates. There is a brief courtship, during which the pair clean the surface of a broad leaf of a water plant. When this is ready, the female lays rows of eggs on it. Sometimes the surface of a stone is used but only after being meticulously cleaned. Once the eggs are laid the male swims over and fertilises them. The parents take it in turn to fan them with their fins and they hatch in about 50 hours. As each baby breaks out of

the egg it is removed in the parents' mouth and placed on a leaf, where each hangs by a short thread for the next 60 hours. The parents continue to fan with their fins and when, at the end of this time, the babies are about to swim, they swarm on the side of one of the parents and appear to hang there. After a time the parent grows restless and the fry are shaken off towards the side of the other parent, who is swimming nearby. When 3-4 weeks old, the fry become independent and feed on small, normal plankton such as very small water fleas or their larvae. At first, they are the *gourami* fish shape, if a little plump in the body. The discoid shape comes with age.

Baby food in doubt

There can be little doubt that baby pompadours get protection by swarming on the side of the parent, although sometimes they

are eaten by the parents at least in aquaria. The question is whether they get something more. In 1950 Dr W H Hildebrand reported observations that seemed to show that the babies fed on a slime secreted by the parents' skin. This seems to have been accepted by students of tropical fishes. In the 1960 edition of their book, *Aquarium Fishes*,¹ Dr Derek McInerney and Geoffrey Gerard not only state that the parents secrete a 'richly nutritious' over their bodies but that the fry will eat nothing else. They quote Mr R Skappet, who has successfully raised several spawnings, and he claims they will not thrive on any alternative food. Indeed, he maintains the 'only hope of raising them is to leave them with their parents. Against this we have the words of Gantner Streib, in his *Freshwater Fishes of the World*, that not only do the young of some other cichlid fishes cling to the sides of their parents but that at least one against has

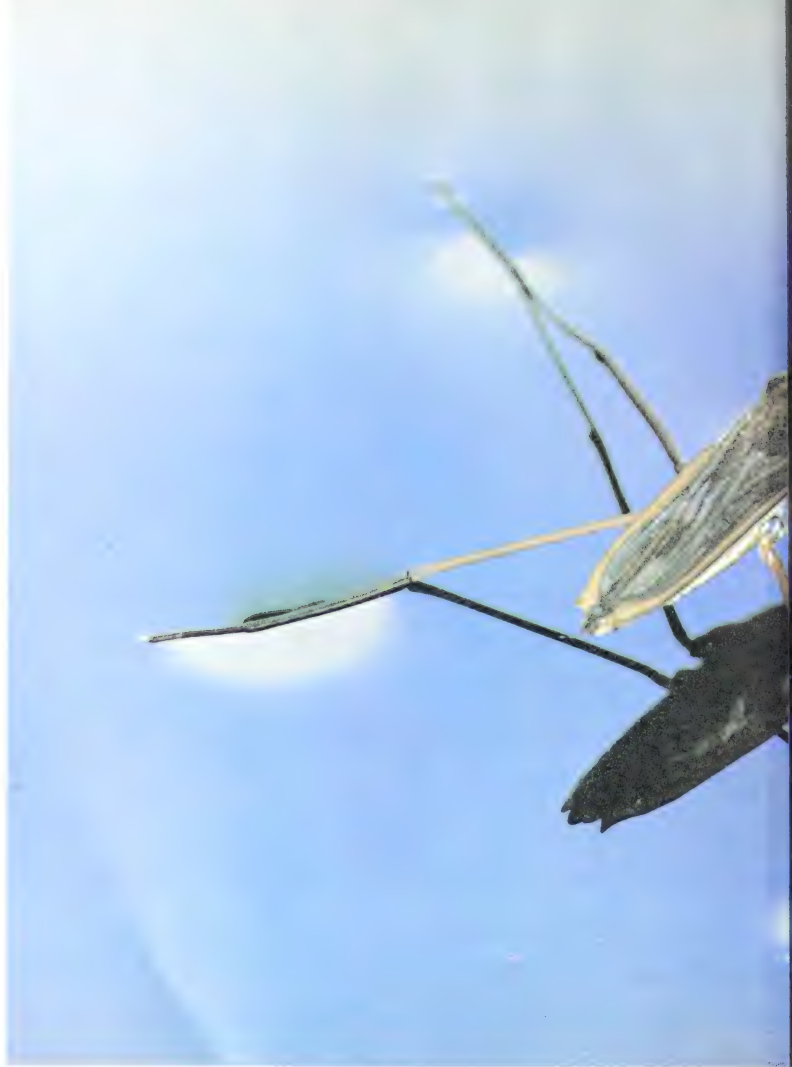
seated, eating, pompadours about from their parents.

One reason left pompadours are not more often kept in aquaria is that young ones taken in the wild are infected with *Microsporidium*. The frequent changes of water necessary to keep them in captivity seem to favour the parasites, which get the upper hand and kill the pompadours.

Class	Pisces
Order	Perciformes
Family	Cichlidae
Genus	<i>Symphysodon</i>
Species	<i>S. discus</i> <i>S. discus</i> <i>S. discus</i>

Thelapia discus (Günther), *Symphysodon discus* (Günther) in the *Shanley*









Shadow and symmetry—even the pond skater's leg hairs make a beautiful pattern on the water. Shown right, a pond skater spreads its legs and on the glassy surface of the water.



Gripping iron? Pond skater's leg with water-resistant hairs and a claw for catching prey.

Pond skater

Pond skaters are insectoid, and are the most common aquatic insects seen floating on the surface of ponds, streams and flooded ditches. Their bodies are flat, narrow, and $\frac{1}{2}$ – $\frac{3}{4}$ in. long. They appear to have only two pairs of legs, but the front pair are short and held close to the head, just behind the antennae. The rear two pairs are long and the tips are fringed with hairs, which rest on the surface of the water. Some species are wingless, others have small wings while a few have fully developed wings. Pond skaters develop through a series of moults from a small nymph. An adult bug can usually be distinguished from a nymph by its fully developed wings, but adult pond skaters are not so easily recognised because one with small wings could be a nymph or an adult, depending on the species.

While true pond skaters belong to the family Gerridae, other bugs that float on the surface of water are sometimes called pond skaters. These include the water measurer, or water penny, family Hydropsychidae, which has a curious long, narrow head and two water-repellent of the family Velidae. There are also the pondwater bugs of the family Mesoveliidae. One member is terrestrial, living among fallen leaves in the forests of New Guinea.

Running on water

Pond skaters often gather in groups along the edges of ponds and lakes, waiting for the water when disturbed and then regroup-

ing. They are propelled by the long pair of middle legs and steered by the hindlegs. When moving slowly, each flick of the legs sends the pond skater sliding several inches over the surface of the water, but they also hop across the water, rising an inch or so at each bound. Water plants present no obstacle and pond skaters walk over floating weed and even over dry water lily leaves.

Pond skaters prey on dead or dying insects which fall onto the water, grasping with their front legs and piercing the bodies of the prey with their mouthparts and sucking them dry. Cannibalism is common. Prey is detected by sight or by vibrations picked up by sense organs on the legs. One European species lives in estuaries and is also found around the coasts of the Baltic Sea. Pond skaters of the genus *Halobates* are among the very few marine insects. They live in tropical and subtropical seas, sometimes hundreds of miles from land, skimming over the waves and feeding on floating dead animals.

Adult hibernation

In temperate regions there are one or two generations of pond skaters each year, depending on the species. The second generation hibernates on land, but occasionally takes to water on warm winter days. In the spring and early summer they return to water and mate. About 100 eggs are laid in groups on submerged or floating plants and covered with mud. They hatch in about 2 weeks, depending on the water temperature, and a month later the nymphs finally change into adults.

Invisible support

The best time to watch pond skaters is on a sunny day. The tip of each leg can be seen to be in a dent in the water surface. If the

water is shallow the shadows of the pond skaters can be seen on the bottom, and each leg is surrounded by a round shadow made by this dip. It is caused by the weight of the pond skater pressing the legs into the water, but it does not sink because the force of surface tension is counteracting this weight. The surface tension is due to a film of closely linked water molecules on the surface of the water which acts like a very fine rubber sheet. It is a very weak sheet and normally we do not notice it. It is this force of surface tension that holds a drop of water in a globe on a polished surface instead of spreading out in a film. The capacity of surface tension to keep objects afloat can be demonstrated by floating a cigarette paper in a glass of water and gently placing a needle on it. Eventually the paper becomes waterlogged and sinks, but the needle remains afloat—held up by surface tension.

Pond skaters sometimes enter the water completely but can refloat themselves because the undersides of their bodies are covered with a dense pile of hairs that trap air and prevents the body from becoming wetted. It has been said that a marine *Halobates* becomes wetted and drowned if a drop of rain lands on its back, but if this is so it is surprising that they have not been wiped out by tropical storms.

phylum **Arthropoda**

class **Insecta**

order **Hemiptera**

family **Gerridae**

genus ***Gerris lacustris***

& species ***G. thoracicus***

G. remigis

others

Pond snail

To some people, any kind of freshwater snail is a pond snail, even if it lives more often in rivers. The name, however, is usually restricted to those snails with pointed spires and more or less oval mouths to their shells that make up the family *Lymnaeidae*. They are the commonest freshwater snails in both Europe and in North America.

Freshwater snails are of two main kinds. One group includes the river snails *Viviparus* and valve snails *Valvata* which, with their marine relatives, can close the openings of their shell with a lid, or operculum. The others lack opercula, and are called *Pulmonata* because they have a lung, formed by the mantle cavity. The true pond snails, those we are dealing with here, belong to the second group, as do the bladder snails *Physa* and ramshorns or trumpet snails *Planorbis* and *Planorbarius*. These are called wheel snails in North America. In the true pond snails there is a lobe of tissue by the opening of the lung that forms a breathing tube, a kind of snorkel.

One of the largest species is the great pond snail which grows to about 2 in. long, depending largely on the volume of water in which it has grown. At the other extreme, a full grown dwarf pond snail may reach only $\frac{1}{4}$ in. Unlike the shells of trumpet snails and bladder snails, those of pond snails are usually coiled to the right; the whorls increase in a clockwise direction as seen from the tip of the spire. In the ear pond snail the last whorl of the shell is greatly expanded, to give the whole an 'ear' shape, and this peculiarity is taken to an extreme in the bubble-thin shell of the glutinous snail. This species is unique in that the mantle tissue can spread outside the shell and all but cover it, so making the snail look like a little dab of glue. The shells of pond snails are generally a dark or pale horn colour and are carried with the spire directed backwards. The ear pond snail, however, points its spire to one side.

On the head are two non-retractile tentacles, each with an eye at the base, and in these respects the pond snails and other freshwater *Pulmonata*, known collectively as *Basommatophora* ('basal-eyed ones') contrast with the garden snail and other *Stylomatophora* ('stalk-eyed ones'). The latter have two pairs of tentacles which can be pulled into the body and the eyes are borne at the tips of the hindmost pair.

Not always in ponds

Pond snails creep along by waves of muscular contractions moving forward over the foot, and sometimes crawl upside down at the surface of the water. Some pond snails, like the great pond snail, crawl to the sur-



An adaptable species, the wandering pond snail can live in a number of habitats, and survives long periods of drought. Unlike most pond snails, it eats both plant and animal matter.

face at intervals to renew the air in their lungs. If they cannot reach the surface, as when they are under ice, they accelerate their normal skin breathing. There are some species that depend entirely on the exchange of gases through the skin and have their 'lungs' permanently filled with water. Pond snails have also been known to survive being frozen.

Pond snails live in a variety of freshwater habitats, though with the exception of the ubiquitous wandering snail, they do not colonise very soft or acid water. While some require large bodies of water, others, like the marsh snail and the dwarf pond snail, flourish in ditches or simply on wet mud, and can survive long periods of drought. A wandering snail has been known to survive 4 years in a dry aquarium, that had been stored away in an attic.

Cannibal snails

Some pond snails live mainly on scum-like algae and other plant material, which is why they are kept in aquaria, to keep the glass cleaned of algae. On the other hand, the great pond snail feeds on animal as well as plant matter and will even kill such lively animals as newts, sticklebacks and the larvae of water beetles. Some species will eat carrion or even resort to cannibalism. All rasp their food to tiny fragments with their file-like tongue, or radula, which is covered with thousands of teeth (see picture on page 6).

Mating chain reactions

Pond snails are hermaphrodite, each in individual having male and female organs opening separately to the exterior. In the dwarf pond snail, a single individual fertilises itself. Tens of thousands have been reared in the laboratory without cross-

fertilisation being seen. Usually one individual fertilises another, one taking the part of a male in every mating and the other taking the part of the female. Sometimes the one acting at that moment as a female acts simultaneously as the male to a third individual and in this way chains of mating snails may be built up. Reciprocal exchange of sperms between two snails is also possible.

Eggs are laid in gelatinous plates or cylinders attached to a firm support, with 2–100 eggs in each mass according to species and food supply. Development is rapid; in the dwarf pond snail young snails may emerge from the egg mass in 2 or 3 weeks and mature sexually within another 3 weeks.

What is a species?

To many people all pond snails must seem utterly insignificant and beneath notice. Yet, as host to the liver flukes, the dwarf pond snail has caused the deaths of millions of sheep (see fluke p. 789). It is not strictly a water snail in that it flourishes on damp mud, feeding on the algae on the surface. A connection between liver rot and damp places was known for a long time but it was the discovery of the role of the snail that opened the door to effective control of the disease. Other water snails are hosts to other kinds of flukes, including human blood flukes. Each species of fluke is to some extent limited to particular snail species. Specifying the snails that support flukes is one of the main problems facing those who study the liver fluke. In Britain and many other countries, only the dwarf pond snail does so, but other species with similar habits may take its place elsewhere. Even in relation to the dwarf pond snail, however, the situation is not

the eggs are attached to the sides of the egg tubes. The egg tubes are usually made of a material that is not digestible by the larvae. The egg tubes are usually made of a material that is not digestible by the larvae. The egg tubes are usually made of a material that is not digestible by the larvae.



Mollusca
Gastropoda
Pulmonata
Basommatophora
Lymnaeidae
Lymnaea truncatula

L. pubescens (syn. *pubescens*)
L. stagnalis (syn. *stagnalis*)
L. emarginata (syn. *emarginata*)
L. peruviana (syn. *peruviana*)
L. emarginata

Myas glutinosa

Fig. 1. (a) In the light, the egg tubes of the great pond snail on the underside of pond weed. (b) Great pond snails leave the algae which grows on plants, the side of the tank and on other snails.





Poor-will

This is the first bird that has been proved to hibernate. It is a nightjar, 8 in. long, with the inconspicuous brown plumage typical of nightjars. The back is mottled and the underparts barred. The throat is white, bordered with black and the short tail is white-tipped. The short wide bill has a very big gape, and is surrounded by long bristles. The eyes are large. It looks like the whip-poor-will shown except for smaller size and less white in the tail.

Poor-wills live in western North America, from southern Canada to Mexico.

Heat resistant birds

Unlike most other nightjars the poor-will is not confined to woodlands, but is also found on prairies and in country whose only cover is scattered sagebrush. It is even found in such hot places as Death Valley in California. It keeps cool at temperatures above 38 C. by panting, so losing heat by evaporation from its respiratory passage. Poor-wills are better able to withstand high temperatures than many birds and mammals because they have a very low basal metabolic rate, the speed of body processes when at rest. Therefore the body does not produce much heat when the poor-will is inactive, so less of a strain is placed on the heat-controlling mechanisms, like panting.

Poor-wills are nocturnal, roosting inconspicuously by day on rocks or branches and becoming active at dusk when they can be seen flying low over roads like giant moths. They are more often heard than seen, for they call on and off throughout the night, especially in spring and late summer. The poor-will gets its name from this monotonous and persistent two-note call. At close quarters a third note can be heard and the call can be rendered as *poor-will-dee-oo*. Two other North American nightjars are named

after their calls: the whip-poor-will and the chickadee-whisperer. The latter one, the more rapid of the two, has its note formed by a series of chirps and whistles. The record for continuous repetition is held by the whip-poor-will that could continue on successively

Night hunter

Poor-wills catch nocturnal insects such as moths, beetles and bugs, as they fly swooping then up in the trap formed by the wide open tail and the surrounding bristles. The hard parts of the insect's bodies are ejected as pellets. Poor-wills hunt nearer the ground than other nightjars and sometimes search for insects on the ground.

Snake-like hiss

Poor-wills nest in May and June. The two eggs appear white but on close inspection are cream with a pinkish tinge. They are laid in a shallow scrape in the earth or on bare rock or shingle, sometimes in the open but more often under a bush. The parents probably share incubation. They sit so tightly on the eggs it is sometimes possible to handle them on the nest. Sitting poor-wills are very difficult to find as their mottled brown plumage blends in with the background, but if disturbed they utter a very snake-like hiss that may deter predators or raise the wings high above the back.

Poor-wills hibernate

For 1000 years it has been suggested that some birds hibernate, and it was even suggested that swallows spent the winter at the bottom of ponds. Once it was shown, however, that the birds which disappeared at the end of summer had migrated to warmer countries, the idea of birds hibernating was abandoned. Yet it was discovered that hummingbirds became torpid at night and outside, swifts became torpid when bad weather prevented their parents from feeding them. Temporary torpidity is not the same as true hibernation and

it could not explain the long sleep of birds in winter. It was the discovery of the hibernating poor-will in the Chihuahuan Desert.

It proved that birds hibernated only once in their lives. Dr. Jaeger discovered a hibernating poor-will in the Chihuahuan Desert in 1937.

The Bang Indians were apparently well aware that poor-wills could hibernate, for they call it the sleeping one, yet there are only two well-documented reports of hibernating poor-wills. This may partly be due to the extreme difficulty of finding them. Jaeger found his poor-will by sheer chance, in a small depression in a granite wall. At first it showed no sign of life, but as it was replaced in its depression it lazily opened one eye and shut it again. Two days later Jaeger returned to find the poor-will in exactly the same position. He could not detect any heartbeat or breathing, and the poor-will's body temperature was 18 C. (64 F.), 10 F. lower than normal. A numbered ring was placed on the poor-will's leg and for four successive winters Jaeger found it in the same rock depression. Hibernation in birds had been proved.

Although only two hibernating poor-wills have been found in the wild they have been induced to hibernate in captivity. They become torpid when the air temperature drops to 15 C. (59 F.) and the food (insects) consumption, an indicator of life, falls to one-half rate. It has been shown that these birds need 100 days of torpidity to survive, and 100 days of activity to return to normal. It is sufficient to sustain a bird in torpidity for 100 days, but it is not sufficient to return to normal after the winter dormant season.

Class	AVES
Order	Caprimulgiformes
Family	Cypselocolapidae
Genus	<i>Cypselocolaptes</i>
& species	<i>Cypselocolaptes velox</i> (Aud.)

Cypselocolaptes velox (Aud.)



Merriam & Grieser

Porbeagle

This shark, up to 12 ft long, but usually only 6 ft, lives in the Atlantic, as far north as Scotland and Iceland in the east and New Jersey in the west. Its name is said to be a combination of porpoise, from its general appearance, and beagle, from the way it hunts.

The porbeagle is plump and full-bodied but tapers sharply towards the tailfin, which is shaped like a new moon but with the upper lobe larger than the lower. The back is dark blue-grey, the belly white. The snout is sharply pointed and contains a large, crescentic mouth in which the jaws are armed with 3 or 4 rows of slender awl-like teeth with small cusps at the base. The lower teeth are directed upwards or slightly backwards. The gill slits are large, the spiracles small.

The pectorals and the first dorsal fin are large, the second dorsal, pelvic and anal fins are small. There is a keel on either side at the base of the tail.

There has been confusion in the past between the porbeagle and the mako, a larger shark, up to 13 ft, with a weight of 1 200 lb, more slender in the body and with a longer more pointed snout. Its teeth have no small cusps. It ranges through the whole Atlantic Ocean.

The North Pacific counterpart of the porbeagle is the salmon shark, which differs in the dark blotches on its underside. The Indo-Pacific mako is very like the Atlantic mako and may even represent the same species. It extends as far south as New Zealand. The sharp-nosed mackerel shark ranges from Cape Cod to the West Indies and there is the possibility that it sometimes comes into the eastern Atlantic.

△ The porbeagle or common Atlantic mackerel shark can be distinguished from the other members of the mackerel shark family by having two instead of one stabilising keel on either side of the tail. The main keel is in the same lateral position as in the mako and the main outer but there is also a small keel just below this but limited to the tail. It can also be distinguished by its teeth which point upwards and slightly backwards and are smooth and slender, unlike those of the mackerel.

Chewing small boats

The porbeagle and the mako shark are aggressive and dangerous to man, the mako more especially, and this is also given to attacking small boats, leaving its teeth behind in the timbers. Indeed, the mako more than any other fish has the reputation for doing this. Yet there are no records of it having attacked bathers in the Atlantic and very few elsewhere, probably because it does not come close enough ashore.

There has been so much confusion, with makos being called porbeagles and vice versa, that such noises as there are on the habits tend to have little value. We can speak on these in only general terms. Both oceans the porbeagle is often seen near coastal waters.

The only information about the breeding is that the females give birth to live young, as shown by captured sharks being opened up and found to contain four or more young, 22 ft long and up to 20 lb weight.

Swift hunters

The food of a porbeagle is mainly fishes. In the North Atlantic they take herring, cod, whiting, hake, mackerel and dogfish. They also eat squid. The reputation of the North Pacific porbeagle is no better, judging by its common name. The mako will overtake the swordfish which has been credited with speeds of up to 60 mph, either biting off its tail or swallowing the whole fish in one gulp. One record is of a 730lb mako with a 120lb swordfish in its stomach.

Sporting nuisance

Porbeagles are not normally used for food and those caught are either thrown back into the sea or used as manure. The oil from their liver has sometimes been used, a 9ft shark yielding up to 11 gallons of oil, and in New Zealand the Maoris once used the teeth as personal ornaments, worn especially in the ears. The deep-sea angler finds they give good sport, being swift and strong, the mako being especially famous for its leaps. The fisherman, on the other hand, has long suffered from their nuisance value. They sometimes get wrapped in drift-nets at the surface and they get mixed up in salmon and mackerel nets. People who have seen the sharks well out at sea speak of their 'dashing madly about' in pursuit of fish, and they probably attack fish in nets with the same crazed vigour, wrapping themselves up in an inextricable mass of twine. The long-line fisherman is not spared either since porbeagles and makos feed near the bottom as well. They snap the fish on the hooks on long lines and in the early years of this century a shark, porbeagle or mako, was taken from cod nets in the Firth of Forth, in Scotland. It had already been at the long lines somewhere else because in its stomach were 11 hooks with their snoods. One can picture it having swum along a long line snapping one hooked fish after another as it went.

class	Selachii
order	Pleuronotemata
family	Isuridae
genera & species	<i>Isurus glauca</i> Indo-Pacific mako <i>I. oxyrinchus</i> Atlantic mako <i>Lamna ditropis</i> salmon shark <i>L. nasus</i> porbeagle <i>L. tigris</i> sharp-nosed mackerel shark

Porcupine fish

When relaxed the porcupine fish has much the shape of an ordinary fish, but when it blows itself up its body becomes almost spherical with long spines bristling all over it. Its tail and mouth look very small compared with this greatly distended body. It has large eyes, and the dorsal, anal and pectoral fins are of moderate size. Porcupine fish are about 1 ft long but may be as much as 2½ ft. In the same family are the burrfishes which have short spines that are always erect.

Doubly armoured

When disturbed or alarmed, porcupine fish inflate their bodies by drawing in water. The body swells, and the spines, which have been lying flat, are erected, standing out almost at right angles to the surface. If a porcupine fish is taken out of water and decapitated it blows itself up by drawing in air.

The spines, which may be 2 in. or more long, are sharp and anyone handling an inflated porcupine fish should wear gloves. Each of the long stout spines has a three-armed base, the paired arms of which overlap in the skin with those of their fellows, providing a more or less continuous 'coat of mail'. In some species the spines have only two arms at the base and can be raised and lowered without the fish inflating itself.

Porcupine fish which live in tropical seas, are slow swimmers, they swim by waving the dorsal and anal fins, helped to a small extent by the pectorals, the tailfin being used for steering.

Eating hard tack

The teeth of the porcupine fish form a continuous plate in the upper jaw with another plate in the lower jaw. Each plate has a sharp edge with a crushing surface behind it. The fishes feed by crushing molluscs

and by biting off and crushing pieces of coral. The flesh of the coral is digested in the stomach. The strong matter in the coral is crushed by the dental plates, accumulates and one porcupine fish dissected had over 1 lb of crushed coral rock in its stomach.

The shark's dilemma

Nothing is known of the breeding habits of the enemies of porcupine fish. There are very few records of what happens when they are attacked but Dr William Beebe, distinguished American marine zoologist, watched some porcupine fishes threatened by a 4ft garfish bunch together for protection. They looked like one large round prickly fish. Then, for no obvious reason, from time to time one would leave the mass and swim away, to be promptly seized and eaten by the garfish. By contrast with this, Robert Hegner, in his *Parade of the Animal Kingdom*, takes the view that if a shark is foolish enough to swallow a porcupine fish it will pay dearly for it. According to him, when the prickly fish reaches the shark's

▽ Submarine satellite, Free-swimming porcupine fish *Diodon hystrix* blown up with water.



stomach it gives out what Darwin called a 'most beautiful carmine-red fibrous matter', which is supposed to protect the fish from the shark's digestive juices. Thus protected it starts to cut and crush the wall of the shark's stomach and body wall until it reaches the sea and freedom.

Sharks have been seen to swallow these fishes but we can only surmise what happens inside them. Craig Phillips, in *The Captive Sea*, says that the surest way to ruin a net is to catch a porcupine fish in it. The more tightly the fish feels itself imprisoned the more it blows itself up, and its body remains inflated with the spines sticking out. Phillips deals with this fish by inserting a plastic tube into its throat, which deflates it. Does a shark suffer the fate of the net, as Hegner suggests, or has it some trick of deflating its prickly victim?

Somewhat useless fish

South Sea Islanders used to make war helmets of the dried skins of porcupine fishes.



*✓ Careful guidance for a porcupine globe fish. Its spines may be up to 2 in. long
 ✗ Porcupine globe fish swimming slowly along the sea bed, its spines lying flat. The spines are only erected when the fish inflates itself*

In the Far East they have been used as lanterns, the dried skin hung up with a candle inside or, in more modern times, an electric bulb in it. In southern England it used to be common to see a dried dead porcupine fish hanging in a fishmonger's shop, acting as a sort of trade sign. These are about the only uses man makes of the porcupine fish except that in some parts of the world it is eaten. It has a bad reputation, however, and care and know-how are needed in preparing the fish for the table because a poison in its liver and skin can contaminate the flesh if the cook does not prepare it correctly.

class	Pisces
order	Tetraodontiformes
family	Diodontidae
genus & species	<i>Diodon holacanthus</i> <i>D. hystrix</i> porcupine globe fish, others



Porpoise

Those of us who have seen small whales from the shore or the deck of a ship may have wondered whether they were porpoises or dolphins. Quite often the names are used arbitrarily to cover any small whale and the situation is complicated because the common porpoise of Americans is the bottle-nosed dolphin of the British, while the British common porpoise is the American harbor porpoise. Often little more is seen than a rolling back some distance out at sea, but with a good view it is quite easy to distinguish a porpoise from a dolphin. Common and bottle-nosed dolphins are larger than porpoises which reach a maximum of 6 ft, but the main distinguishing features lie in the shape of the body. Porpoises have less streamlined bodies and blunt snouts, lacking the 'beaks' of the dolphins. The flippers are broad and rounded, those of the dolphin curved and tapering. The back fin, the part most often seen, is small and fairly square in the porpoise but more conspicuous, curving backwards to a point in the dolphin.

There are four species of common porpoise. *Phocaena phocaena* lives in the eastern Atlantic, from the Arctic sea to the coast of West Africa, as well as in the Mediterranean and Black Seas, and in the eastern Pacific from Alaska to California. *P. sinus* lives in the Gulf of California, *P. spinipinnis*, Burmeister's porpoise, on both sides of South America, from the River Plate to Peru and *P. dioptrica* the spectacled porpoise, ranges from the River Plate to South Georgia.

Closely related to the common porpoises are Dall's and True's porpoises,

Phocaenoides dalli and *P. truei* of the North Pacific, and the finless porpoise, *Neomeris phocaenoides* of coasts and rivers from India to China.

Not so playful

Porpoises live in coastal waters and are often found in estuaries, sometimes penetrating far up rivers. One porpoise was found as far up the Rhine as Cologne. They live in pairs or in schools of up to 100 and are migratory. Little is known about the courses and timing of the migrations but porpoises are most numerous in the North Sea in July and August. Porpoises leave the Baltic Sea between November and February and if the sea freezes early they are killed in large numbers.

A difference in behaviour between porpoises and dolphins is that porpoises are less playful. They rarely leap out of the water and do not follow boats as often as dolphins.

Slippery food

Porpoise feed mainly on fish, together with some squid and crustaceans. The fish caught are pelagic rather than bottom-living species, which accords with the porpoises' way of



Phocaena phocaena



Arthur Chlodjewski

life. They usually swim near the surface but have been caught in nets 200 ft or more deep. Fish more than 1 ft long are rarely taken, their favourite being herring, pollack, whiting, cod and sardines are also taken. Porpoises are frequently accused of eating salmon as they enter estuaries, but there is little firm evidence for this. True's porpoises have been found with lantern fishes in their stomachs. These are deep-sea fishes that come to the surface at night.

Although porpoises are armed with 16–27 teeth on the sides of each jaw, they swallow their prey whole. The teeth are spade shaped and are used for gripping slippery animals. Dall's and True's porpoises which feed largely on cuttlefish have a full set of teeth but these never show through the gums.

Suckled at the surface

Porpoises mate between July and October, gestation lasts nearly a year, the single baby rarely being born before June. The babies, which are suckled for 8 months, are half the length of the mother when born. When suckling, the mother porpoise 'blows' lying on her side. This allows the blow hole of the baby to break the surface without it having to release the nipple. Porpoises live about 15 years.

Royal delicacy

Porpoises fall prey to sharks and killer whales, and at times are hunted by man. They are eaten by Indians living on the coasts of North and South America. In Normandy there was once an important porpoise fishery. The meat was eaten and the blubber rendered into oil for lighting. In mediaeval England, porpoise flesh was considered a royal dish.

Surf riders

Although they usually ignore boats, porpoises share with dolphins the habit of riding in the bow waves of fast-moving ships, being swept along almost effortlessly. KM Backhouse and PJG Smart have described this behaviour in the *Proceedings of the Zoological Society of London*. The porpoises were swept forward with their tail flukes in the breaking part of the wave. The bow wave of a ship is caused by water being thrown out of the way, over the top of the water immediately ahead. A large, fast-moving ship sweeps a considerable wall of water in front of it. The porpoise, or dolphin, uses this to propel itself in much the same way as a surf rider on his board. The trunk is raised so that the tail flukes are presented to the rush of water which lifts the porpoise as well as moving it forwards. Both surf rider and porpoise have to keep the forepart of the body clear of the slower water in front of the body which would pull it down. Humans use the surf board to provide lift at the front while porpoises use their flippers. Small boats do not provide large enough waves for riding. Porpoises have been seen trying to ride them but they either get left behind or suffer the same fate as the incautious surf rider: there is not enough lift so their heads sink and they are thrown tail over head.

class	Mammalia
order	Cetacea
family	Delphinidae
genera	<i>Neomeris</i> <i>Phocaena</i> <i>Phocaenoides</i>



Port Jackson shark

The prominent nostrils either side of the snout and a toothy mouth, permanently half open, give the Port Jackson shark a repulsive look when seen head on. It is the best known of 10 species of horn shark. They are 4½–5 ft long and are noted for the shape of their teeth and jaws.

The heavy head is blunt in front with a terminal mouth and 5 gill slits on each side. A ridge runs over the top of the head beside each eye. There are two dorsal fins, each with a stout spine in front, large pectoral fins and a single anal fin. The shark is brownish-grey.

The Port Jackson shark lives in the seas off southern and eastern Australia. Other species live in the Indian Ocean and in the Pacific, around the Malay Archipelago, Japan, the Galapagos and off California. They are a primitive race of sharks related to those whose fossils date back 150 million years, to the Jurassic period. The large spines associated with the fins were a feature of the forerunners of sharks and also of the earliest known true sharks.

Tombstone teeth

These fairly sluggish sharks live near the bottom of shallow waters where they feed mainly on clams and other molluscs, and crustaceans such as crabs, which they crush with their unusual teeth. The upper jaw fits into a deep groove and is attached to the cranium by strong ligaments; the lower jaw is slung from the cranium by the hyomandibular cartilage. The jaws themselves are lyre-shaped and the teeth have an unusual pattern. In the front half of each jaw they are very small, cone-shaped and numerous, crowded together and looking rather like the teeth of a file. About halfway along the jaw they begin to get larger and these larger teeth are abruptly replaced by two rows of very much larger flattened teeth, with four rows of medium-sized teeth beyond these at the rear end of the jaw. Although nothing is known of how these sharks feed it is reasonable to assume that the small teeth in front of the jaw are for seizing prey and passing it backwards into the mouth to be crushed by the large pavement-like grinding molars.

Buried eggs?

There is a sort of courtship in which the male nuzzles the female at various points on her body until mating occurs. As in all sharks, the male has a pair of claspers

△ Dazing shark—the slightly grotesque

Port Jackson shark has a large bulbous head and a sharp spine on each of its dorsal fins.
▷▷▷ 150 million year old fossil relative.

▷▷ Teeth of Californian horn shark. The small sharp front ones probably seize the prey, the flat back teeth acting as crushing plates.

▷ In hand—a female Californian horn shark and two of her strange corkscrew shaped eggs.

associated with the pelvic fins. It used to be thought that these were used to clasp the female during mating but fairly recently it has been realized they are used for transferring sperm to the female, fertilisation being internal. The eggs are laid one at a time at fairly long intervals over a period of 2 months. Each is in a cylindrical capsule of a brown horny material. Around the cylinder, which narrows at the lower end, are two spiral flanges. Each capsule looks very like the end of a post-hole drill. As they float down through the water their shape probably causes them to spiral and it is hard to believe the capsules do not anchor themselves in the sand by this boring, twisting action. If they do, this may be a protection against the eggs being eaten by bottom-feeding fish—such as the Port Jackson shark! The eggs take 7–8 months to hatch, the baby fish being 8 in. long when it leaves the capsule.



Poison spines

The spines on the front of each of the dorsal fins are formidable weapons. As well as being vicious spikes they are grooved and the tissue in the grooves gives out a poison which can cause painful, possibly dangerous, wounds in human beings. The main enemies of a 'til shark are likely to be other larger sharks, and fishermen, as their flesh has a delicate and excellent flavour when cooked. Against other sharks a sluggish swimmer like the Port Jackson shark is unable to use speed to escape. It therefore needs some form of passive defence. It is known that pike learn to leave the 'spined stickleback alone. Perhaps in the same way other sharks learn to keep out of harm's way by giving the Port Jackson shark a wide berth.

class	Selachii
order	Heterodontiformes
family	Heterodontidae
genus	<i>Heterodontus</i>
species	<i>H. francisci</i> <i>C. (H.) francisci</i> <i>H. philipi</i> <i>Port Jackson shark</i>

Portuguese man-o'-war

This colourful jellyfish with a sting almost as powerful as a cobra's venom floats on the surface of the sea in mid-ocean. Occasionally thousands are cast up on the coasts by strong winds. Each Portuguese man-o'-war is in fact a colony composed of four different kinds of polyp. The most obvious part of the Portuguese man-o'-war is a bladder-like, gas-filled float. This polyp may be up to 12 in. long, 6 in. high and 6 in. across. It carries a high crest and its colours range from blue through purple, lavender and pink to scarlet. On the underside of the float and hanging down in the water, are many polyps. Some are concerned only with feeding, others with reproduction, while the long trailing tentacles armed with stinging cells that may be 40 ft long, are used for catching the prey.

Physalia, as it is scientifically called, is found in warm seas throughout the world but especially in the North Atlantic where it is normally restricted to the area covered by the circulatory currents of the Gulf Stream. It is common in tropical and subtropical areas of the Indian and Pacific Oceans, and off the coast of New South Wales, Australia, is a particular nuisance to bathers and is known as the bluebottle.

Helpless but dangerous sailor

The wind catches the sail-like crest on the float of the Portuguese man-o'-war, and drifts it across the sea. The float can be deflated in storms and then the jellyfish submerges. The bladder is filled with a mixture of gases secreted by a gas gland. The gas is similar to air but contains more nitrogen as well as carbon monoxide, argon and xenon. The pressure of the gas is regulated by muscles in the thin membrane forming the wall of the float. Under normal conditions these cause the float to twist and contort from time to time, so the bag is dipped into the water, keeping its outer surface moist. After being deflated the float can be reinflated in a few minutes. On a rough sea tentacles are spread all around the float to keep it on an even keel.

The Portuguese man-o'-war may be caught in persistent winds, blowing from one quarter over a period of weeks, and carried hundreds of miles from their normal range to be cast up in large numbers on the coasts of Europe or the United States. When this happens the bladders lie scattered in the drift line on the shore, the tentacles and polyps soon becoming shrivelled and dried. Even when dried the stinging cells are dangerous and when handled carelessly, can produce a red weal on the skin like a severe burn.

◁ Driven along by the wind catching its float, *Physalia physalis* sails close to the rocks.
▷ A mass of deceptively beautiful trailing tentacles floats above a mushroom coral.



Increase a thousand-fold

In a well-grown Portuguese man-o'-war there may be a thousand polyps and they all come from one larva. This grows into a tiny bladder with a gas gland at one end. At the other end a tubular mouth grows out. This is the first feeding polyp. Between the bladder and the first feeding polyp there appears, at a later stage, what is called the budding zone. The first stinging tentacle grows out from this, to be followed by more feeding polyps and stinging tentacles. By further budding the reproductive polyps are formed, some male, others female. The bladder meanwhile has grown into a float with a crest. It continues to grow in size and the three kinds of polyps increase in number by budding until the mature jellyfish is formed. It probably lasts only a few months but before dying it sheds its eggs and sperm into the sea. The eggs are fertilised and from them the tiny larval bladders develop.

Turtles wolf jellyfish

In spite of their vicious stings the Portuguese man-o'-war is eaten by several animals, especially by the loggerhead turtle (p. 1338). This has been seen to eat its way through a shoal of the jellyfish, its eyes swollen and almost closed from the stings. It seems to be almost immune to the poison and insensitive to the stings. There is also a small fish *Nomeus granovii* which seems to enjoy an immunity to the poison and although it does not prey on the jellyfish it robs it of some of its food. This is the small fish long renowned because it shelters among the tentacles of the jellyfish. Only within recent years has it been studied and shown to rob its host. Moreover, although it does not have complete immunity to its host's poison it can survive 10 times the dose that would kill another fish of the same size.

Why man-o'-war?

The first written account of this jellyfish, in English, seems to be in Hans Sloane's *Travels to Jamaica*, published in 1707. In this it is implied that the jellyfish resembles the Portuguese caravel, a ship of 100–150 tons, with a broad bow and high narrow poop. Sloane's diary contains the following entry: 'On Tuesday 11, when we were in about forty-six degrees of northern latitude I first saw what the seamen call a Caravel or Portuguese Man of War, which seems to be a Zoophytem, or of a middle nature between a Plant and an Animal . . . of a blue, purple, yellowish and white colour, that burn more violently than those of the North-Sea, they do suck themselves so close to the skin that they raise Blisters, and cause sometimes St. Anthony's Fire.'

phylum	Coelenterata
class	Hydrozoa
order	Siphonophora
family	Physaliidae
genus	<i>Physalia physalis</i> Atlantic
& species	<i>P. utriculus</i> Pacific and Indian



Photo: Neil

Man-o'-war in action

The poison contained in the stinging cells is 75% as strong as a cobra's venom. Each stinging cell, when stimulated by touch or chemicals in the water, shoots out a long tube, as in hydra (1199), but the surface of the tube in *Physalia* is studded with hooks, barbs and spikes of different shapes and sizes. The tube will even penetrate rubber gloves, and it will go deep into the skin and cause a stinging, locally fatal affliction the moment it touches the skin (see 1200).

The man-of-war, with colonies of thousands of stinging cells, capturing plankton, small fish and small fishes. We saw the stinging cells are shown when the colony is disturbed. They are also shot out when an animal touches the colony into contact with them. The animal is then shot from the colony and the animal is shot from the colony and the animal is shot from the colony.

As a jellyfishing jellyfish, the stinging tentacles, the feeding polyps, which are flask-shaped, become agitated and move their mouths around searching for the food. Once they get the taste of it their mouths open wide and they fasten sucker-like onto the body of the fish. The wide mouths of a colony of feeding polyps spread over a fish and absorb its flesh. The polyps pour digestive juices onto the fish. Smaller prey are eaten directly by feeding polyps.

On left the crest has momentarily heeled over.

Physalia physalis, showing the capsule.





Potoo

Potoos or wood nightjars are a family of 5 species related to the nightjars. They have large mouths, but lack the nightjars' surrounding bristles. The plumage is dark brown, streaked and mottled with buff, white and black, which makes a potoo inconspicuous. It has short legs and long wings and tail. The eyes are very large with yellow or brown irises.

Potoos live in Central and South America and in the West Indies. The largest is the great potoo, 19½ in. long, with unusual scalloped upper eyelids. The bill has a 3in. wide gape. The great potoo is found from Panama to Peru and southern Brazil. The common or grey potoo is the most widespread, ranging from southern Mexico to Argentina, and is also found in some of the West Indies, such as Jamaica, Hispaniola and Trinidad. It is 17–18 in. long, of which half is tail.

perched in an owl-like posture, with its head facing forward. The captive potoo was very sluggish. This was probably because it was hand-fed and reared and never left its perch of its own free will.

Hawking for insects

Potoos hunt from their perches, keeping still, until an insect flies by, then they swoop out to catch it in the enormous gape and return to the perch. They can catch large insects such as beetles, bugs, locusts and termites. When hawking continuously for insects potoos catch them in the same way as owl-frogmouths (p 1652) rather than like nightjars (p 1574).

Hidden in the open

Potoos lay their white eggs in exposed positions yet very little is known about their nesting habits because the nests are so hard to find. Even when told that a

'[red] Say, ah!'. A potoo's gape is extraordinarily large – an effective trap for its insect prey.
'[red] When relaxed the common potoo looks like a little fluffy toy with glass eyes.

wide, snap its beak and gape aggressively. Potoos also perform distraction displays, flapping and cavoring on the ground.

The incubation period is not known but both parents probably take part. The newly-hatched chick is brooded, after which it perches inconspicuously like the parents, remaining on the stump for about 6 weeks.

Weird calls

One of the features of the potoos and their relatives is their strange calls, often booming, or shrieking, which have given rise to many of their common names, for instance, night-jar, poor-will, whip-poor-will and *guachero* (the Latin American name for oilbird meaning the one who wails). The potoo is also named after one of the cries of the common potoo. This two-syllable call is like a howling cat and in Haiti potoos are called 'howling cats'. Another of its cries is described as 'poor-me-one', a far-carrying, mournful whistling which when heard close-to can be shown to be composed of 7–8 descending notes. As these calls are heard at night it is not surprising that potoos and their



Illustration: P. Wainwright



Bright eyes at night

A potoo may often be first encountered as a pair of large, yellow or brown eyes in the dark. Potoos are nocturnal like their relatives, so very little is known about their habits. They roost motionlessly on very difficult to find. Great and common potoos live in open woodland and plantations, leaving bare tree perches on tree stumps and branches. They are most often seen by moonlight when their large eyes show up as two brilliant, low spots in the headlights. Other rare potoos are usually known only by their mournful calls. Drawings of potoos generally show them as roosting with their tails pointing upwards, but a captive potoo

potoo's nest is nearby it is unlikely that a person will be able to locate it. The single egg is laid in a crevice or depression in a tree stump or the scar where a branch has fallen off. The potoo perches over the egg, covering it with its breast feathers and holding its long tail close to the trunk of the tree. In this position it is easily mistaken for a bracket fungus or the projecting stub of a broken branch. When relaxed the potoo perches with plumage fluffed and head pulled in to its shoulders, but when disturbed the head is extended with the bill pointing skywards and slightly open, the eyes being nearly closed. This makes the potoo even less birdlike and in this posture it can be handled, when it will open its eyes

relatives are connected with superstitions. In Trinidad the oilbirds are supposed to carry the souls of criminals and to the Indians of South America the wails of potoos are evil omens.

class	Aves
order	Caprimulgiformes
family	Nyctibiidae
genus	<i>Nyctibius grandis</i>
& species	<i>great potoo</i> <i>N. griseus</i> <i>common potoo</i> <i>others</i>

Potto

The potto is one of the slow-moving lemur-like lower primates, related to the lorises (p 1345) and angwantibos (p 53). It is 14–16 in. long, with a tail of 2–3 in. (longer than in its relatives) and weighs about 2–3 lb. It has thick, usually dark brown woolly fur, rounded ears nearly hidden in the fur, and big round staring eyes. Like its relatives, it moves slowly. Its thumbs and big toes are long, its index finger and second toe being greatly reduced so that both hands and feet form strong clamps. The index finger is not quite as reduced as in the angwantibo. Its snout is fairly short, the shape of the potto resembling that of a little bear. The most peculiar feature of the potto is its possession of four or five 'spines' on its back. These are the spines of the neck vertebrae which are unusually long so they protrude slightly through the skin. It used to be thought that these spines were for defence, but they are very blunt and are in a very peculiar position to be defensive. Recent examination has shown that they are covered with a thin layer of highly sensitive skin.

The potto lives in the African forest belt from Guinea in the west to the Rift valley in East Africa. In the Congo Republic it is found only in the area to the north of the Congo river.

Not so gentle

Living in deep forest pottos lead solitary lives, moving slowly about at night along the lower branches of trees, spending the day curled up almost into a ball, with the head tucked between the arms and the hands and feet clamped tightly to a branch. At dusk they come out from their hiding place, which is usually a tree-fork or a tangle of twigs and leaves. When two meet on their nocturnal wanderings, they may groom each other, and stay together for a while. The males are probably territorial since they mark branches with the secretion of glands situated near the anus and are often aggressive towards each other, threatening with open mouths and making little downward lunges with their heads. Pottos are fairly aggressive and hard to tame.

As it moves along a branch, the potto lets go with one hand or foot at a time. The hand is moved forward and the fingers close around the branch in a vice-like grip. Then a foot is moved to grip in the same way. This is not a very rapid method of locomotion but the potto is not quite as slow-moving as its discoverer, Bosman, declared in his description of it written in 1704; he spoke of 'its lazy, sluggish Nature; a whole day being enough for it to advance ten Steps forward. Some Writers affirm—that when this Creature has climbed upon a Tree, he doth not leave it until he hath eaten up not only the Fruit, but the leaves intirely; and then descends fat and in a very good case in order to get up into another Tree; but before his slow pace can compass

this, he becomes as poor and lean as it is possible to imagine. And if the trees be high, or the way anything distant, and he meets with nothing on his journey, he must needs of Hunger, depart, one day, and the other'—a slightly frightful way of feeding.

This is highly fanciful, as might be expected from an author who goes on to say: 'It is impossible to look on him without Horror... he hath nothing very particular but his odious Ugliness... I don't believe anything besides so very disagreeable is to be found on the whole Earth.' It is very like poetic justice that, in describing just a lemur-like angwantibo, or golden potto it is often called 'after its discoverer—Bosman's potto'.

▼ *Clinging to a branch, a potto keeps gripping (thumb and foot) from between thumb and index, rounded ears. Its thumb and big toes are long, its index finger and second toes very short, so both hands and feet form strong clamps around the branches.*

▼ *Overleaf: Pottos, rescued and rehabilitated in Uganda. The potto never lets go; it moves only one foot at a time at a time.*



Must hold on to something

Contrary to Bosman, pottos can move quickly when they put their minds to it, which is, however, not very often. They creep up on nesting birds, very slowly so as not to be noticed, and grab the victim with a sudden, swift lunge. This has been reported of pottos in Uganda. In the Ivory Coast, however, the potto is thought to be purely vegetarian. In general pottos eat leaves and fruit, insects, snails, lizards, eggs and young birds. Again, contrary to Bosman, they dislike crossing open spaces, feeling uncomfortable unless their hands and feet are clasped round a branch. They move from tree to tree only when they can do so without descending to the ground first.

Nursemaid puppies

The female comes into season about every 10 days, births, of one baby at a time, occurring at all seasons. The infant clings tightly to its mother's belly, smuggling against her for warmth. A young potto reared at the London Zoo during the last century suffered from the cold, so it was given a hare-skin bag into which it used to go for warmth. A dog in the Zoo had recently given birth, and when the puppies were old enough to walk around they were made to play nursemaid to the baby potto. It would cling to a puppy's belly until the poor 'host' became too uncomfortable, then the potto was transferred to another puppy—but this was a more difficult procedure than it might appear, as the young potto clung so tightly to its foster 'parents'.

Pottos grow rapidly; their spines begin to appear at 30 days. When the mother is moving around in the trees, she often 'parks' her baby, leaving it clinging underneath a branch where it will be quite safe until she comes to fetch it. A potto lived 9 years in Bronx Zoo, New York.

Spines towards the enemy

We are not sure what feeds on pottos. One suggestion was that the palm civet *Nandina* might do so, because of its size and the way it hunts in trees, but palm civet stomachs so far examined have all contained nothing but fruit! Perhaps some of the smaller cats, like the African golden cat *Profelis aurata* feed on pottos; undoubtedly pythons do occasionally. At all events the potto has a well-defined defence response: it curls up, clinging with its hands and feet, its head tucked between its arms as in sleep, turning its 'spines' towards the enemy. If touched or threatened further, the potto will suddenly let go of the branch with its hands and lunge outwards with them at the enemy. At the same time it can inflict painful bites with its small sharp teeth.

What's in a name?

The slow-moving pottos and lorises are, strangely enough, most closely related to the bushbabies, which move as rapidly as the potto does slowly, leaping with their long hindlegs. Yet although so different in their way of life they are very alike in structure. It is hard, for example, to tell their skulls apart. Fossils from the late Miocene deposits of East Africa, 14 million years ago, show that the pottos and lorises, on the one hand, and the bushbaby (or galago) group, on the other hand, had already become separate groups. One of these fossil types given the name *Komba*, is ancestral to the galagos, while confusingly, another named *Progalago*, is ancestral to the potto. Even more disconcerting is the fact that one fossil named *Protopotto* later turned out to be a fossil fruit bat!

class	Mammalia
order	Primates
family	Lorisidae
genus	
& species	<i>Perodicticus potto</i>





Prairie chicken

The two species of prairie chicken are grouse that live in eastern and central United States. The greater prairie chicken is 47 in. long, pale brown with black barring. The face is white with a black stripe. The male has an orange crown, large orange ahrsacs and an epaulette of stiff pointed feathers on the neck which is raised during display. The lesser prairie chicken is similar, but an inch smaller and has violet ahrsacs. The feet are slightly

Before the spread of European civilisation prairie chicken were widespread over the grasslands of the United States, from the Canadian border to Texas and eastwards to the Atlantic. The main centre of their population was the previously vast prairies of the United States, but they also flourished in open woodlands where there were grassy clearings. The lesser prairie chicken lives in country dominated by dwarf oak bush. They are now very much restricted. Predators have had some effect, particularly domestic cats, but radical alterations of the habitat by man is the main cause.

Habitat destroyed

When Europeans first spread westwards in North America, cutting the woodlands down for pasture, the prairie chicken flourished, as its food is grass grains. Later the prairies were ploughed up, robbing the prairie chickens of their homes. This process was accelerated during and after the First World War when grain-growing was a strategic necessity and the development of mechanisation allowed large areas to be cultivated. The prairie chicken became extinct in the eastern part of its range and only survived in isolated pockets. Even more advanced farm machinery threatens some of these pockets but others have been set aside as reserves.

One race of prairie chicken has already become extinct. This is the heath hen, a subspecies of the greater prairie chicken, that used to live along the North Atlantic seaboard in what were probably grasslands then sprang up after forest fires. The heath hen disappeared from the mainland of New England about 1835, but survived on the island of Martha's Vineyard until 1932.

Booming grounds

Like other grouse (p 970) male prairie chickens meet in communal display grounds called booming grounds, which are used from one year to another. The males gather in early spring and every day for several

months, at dawn and dusk, they indulge in their displays. The orange ahrsacs are inflated and the neck epaulette and tail are raised. Once arrayed, the males scurry to and fro and spin in circles with head held low, wings drooping and tail alternately fanned and shut with a loud click. While dancing the prairie chickens utter a three-syllable boom which in chorus can be heard as a continuous humming for up to 4 miles which is the approximate distance between the different booming grounds.

Each male prairie chicken stakes out a territory within the booming ground. Presumably the boundaries of each territory are determined by the effects of the displays on the neighbours. Observations on marked prairie chickens show that territories within a booming ground vary considerably in size and overlap to some extent. Females visit the booming grounds to mate and then depart to rear the family by themselves. The most successful males are those with the largest territories. On a booming ground that was watched for 2 years there were nine males. Each year one of the nine held sway over large territories and took part in about 70% of the matings within the booming ground. Presumably the male with the largest territory was in some way dominant over other males and able to hold a large territory by his displays. In this way most of the prairie chicken offspring are





◁ Below the belt? A prairie chicken charges at his opponent with his beak during a territorial dispute. Each male holds sway over a section of the booming ground, the size of this territory depending on his strength and the effect of his displays on his neighbours.

▽ The critical approach. A proud cock eyes the back of a hen before mounting her to mate. The hens visit the booming grounds to mate. Most of them choose the dominant males—those with the largest territories.

tattered by the dominant male as a final example of selection of the fittest.

The female prairie chicken makes a nest of dead grasses in open grassland or under a bush. The usual clutch is 13, incubated for 3 weeks. The chicks leave the nest shortly after hatching and follow their mother.

Safe in the open

In the course of another study on prairie chickens, booming grounds were watched for 1–15 mornings over 24 years. Among other observations a watch was kept for predators and the reaction of the prairie chickens to them. The results were surprising for all that little soft-footed ground chickens were killed on the booming grounds. Three were killed by hawks, a further 11 snags and a horned owl and only by a mongrel dog from a nearby farm.

Although foxes and coyotes visited the booming grounds none made a kill. It was also noticed that the prairie chickens were more wary of dogs than of foxes or coyotes. The reaction to a ground predator was surprisingly casual. As it approached the prairie chicken walked out of the way with neck stretched up. If pressed it took flight but settled within 100–200 ft. Sometimes foxes were seen to cross the booming ground, taking no notice of the prairie

chickens, who disregarded the foxes.

The conclusion to be drawn from these observations is that predation on the booming ground is far less successful than one might expect. Furthermore, it probably had been higher if sound still have had so effect on the population because as we have seen, one male prairie chicken dominates the mating. If someone is killed, another will take its place. Several instances have been mentioned in this encyclopedia of conspicuousity observed with birds having nothing to do with raising their families and/or survival, of conspicuously coloured females behaving similarly. It is usually assumed that these birds can be coloured because they will not attract predators to the nest, but there is proof that conspicuousness does not usually attract enemies. It must not be noted that as the booming grounds are open spaces, the enemies themselves would also be very conspicuous.

class	Aves
order	Galliformes
family	Tetraonidae
genus	<i>Tympanuchus</i>
species	<i>Tympanuchus cupido</i> <i>Tympanuchus phasianellus</i> <i>T. pallidicinctus</i> <i>Tympanuchus</i>

Prairie dog

Prairie dogs are hamster-like, short-tailed ground squirrels that are so named because of their barking calls. The length of the head and body is about 12 in. and the tail about $3\frac{1}{2}$ in. Apart from being slightly flattened, the tail bears little resemblance to the tail of tree squirrels. The head is more squirrel-like except that the ears are very small. The fur is yellowish-grey or brown with lighter underparts and the tip of the tail is black. The five species are all very similar in appearance.

They inhabit the plains and plateaus of North America, from the Dakotas to

the west to Kansas and Oklahoma in the east, and also in northern Mexico.

Prairie citizens

Prairie dogs live in vast 'towns', although these are smaller than they used to be because such large concentrations of animals inevitably came into conflict with man. In 1901, one town was estimated to cover an area 100 by 240 miles and to contain 400 million prairie dogs. As with other colonial or social animals prairie dogs have a social organisation, which, as must be expected with such vast colonies, is very complex.

A single town is divided into a number of wards, whose boundaries depend largely on the geography of the area. The wards are divided into a number of coteries, each covering less than one acre. The coterie is the base unit on which the prairie dog's life is founded. It is the family unit that defends its territory and individuals rarely venture from it. If they do, they are likely to be chased back by members of neighbouring coteries. A typical coterie consists of an adult male, three adult females and a

variable number of young prairie dogs. The members of a coterie recognise each other and are on friendly terms, and except for the very young ones, they jealously guard the coterie's boundaries. Apart from squabbles along the borders, members of the coterie, including the youngsters, advertise their territories with a display. Rearing up on their hindlegs with nose pointing to the sky the prairie dogs deliver a series of two-syllable calls.

Each coterie has a network of burrows with a large number of entrances. From the entrance the burrow descends steeply for 3-4 yd before meeting radial tunnels with nests at the end. From a distance a prairie

◇ *Passion on the prairies? The greeting kiss inhibits aggression between members of one family, at the same time enabling a trespassing stranger to be detected.*

▷ *Reflecting on more youthful days? An adult prairie dog sits in the sun and relaxes.*



dog town appears pockmarked with craters because each burrow entrance is surrounded by a volcano-like cone. This is more than the casual accumulation of excavated soil; it is a carefully built support of soil 1–2 ft high and up to 6 ft across. The soil is gathered from the surface, brought to the entrance and piled one place where it serves as a lookout post and a protection against floods after heavy rains.

Changing the scenery

Prairie dogs are vegetarians, feeding on grasses and other plants that grow on the prairies. Not surprisingly, the activity of prairie dogs have a profound effect on the vegetation inside the town limits. The underground plants are eliminated. Those on the surface and left to wither if they are not consumed, and the continual cropping of the grasses and herbs encourages fast-growing plants with abundant seeds so the optimum vegetation from the prairie dog point of view is pro-

duced. There is a second function to this unintentional vegetation. The removal of all plants deprives predators (wolves) of all along the prairie dogs' escape route from their mounds.

Perhaps the most remarkable feature of this system is that each prairie dog has sufficient area for feeding and some surplus is provided for use after the prairie dogs enter the posture. When the population gets too big, some individuals spring the little "overspill" betters.

Keeping the balance

The rate of reproduction in prairie dogs is slow compared with many other animals. Each female produces only one litter a year, usually of around four pups in March–April or May. The pups escape in 45 days and they are weaned in 7 weeks.

Although comparatively few pups are born each year, the population can still increase quickly, such as from two prairie

dogs to six in a month. This would threaten the food supply if it were not for natural checks. In fact, it is not so subtle. When the population rises the behavior of the prairie dogs changes. It is only one member of a coterie can enter any burrow and only female can make any pups, but only in females defend their nests from the others. The underground food at the edge of the cone, containing home energy. As the young prairie dogs appear, the overlying cones that, gradually, after their own burrows. The population in this vegetation-bound territory, therefore, the boundaries.

Early-warning system

Prairie dogs tell news to other predators, particularly coyotes and badgers, but in a much subtler way. The sound and look of a coterie underground show how far from a burrow the danger is. As with mammals in the prairie dogs have in alarm all that would then all belong to cover. This is the back then is responsible for their name. It is a short, rapid tip of the head, several shades of meaning. When high pitched it is the signal for immediate flight. The normal call, however, is used as an alarm signal.

The depredations of some predators does not affect prairie dog numbers but the prairie dogs use of the grassy places (which to a being nearly wiped out by man. Man wanted the grasses for his livestock, who were also in danger of bombing their legs in prairie dog burrows. Poisoning was so successful that the towns were wiped out and prairie dogs now survive mainly in national parks.

Kisses seal friendship

The efficient use of posturing and the harmonious life within the coterie are essential for the existence of prairie dog towns, and the whole of the elaborate social system is dependent on communication between prairie dogs. Members of neighbor coterie keep apart by an regular, see ritual but members of a single coterie are drawn together. The basis of the ritual is the exchange of kisses. When two prairie dogs meet near a boundary they drop to their bellies and crawl slowly towards each other. On meeting they bare their teeth and kiss. If strangers, one retreats or a squabble breaks out. If friends, one nibbles the other who rolls over and crosses itself as he groomed, so cementing the friendship. Within a coterie all members groom each other and at times the grooming is prolonged and the pair end up side by side. They then go off to feed with their bodies still pressed together. At other times, two prairie dogs may press exchange quick pecks, but this will contain attention and keep the coterie harmonious.

Class	Mammalia
Order	Rodentia
Family	Sciuridae
Genus	<i>Cynomys</i>
Species	<i>C. ludovicianus</i>

Fig. 1. A prairie dog in its natural habitat.









Pratincole

The name pratincole is derived from Latin *pratin* for 'swallow' and *cola* for 'tail', but the alternative name of swallow player is more appropriate for these relatives of coursers (p 540). They are starling-sized, about 8 in. long and in flight look like large swallows, with long pointed wings and forked tails. Although their legs are short they run well, holding their bodies parallel to the ground. The middle and outer toes are connected by a web of skin and the claw of the middle toe is very long, with a comb, as in herons. The Australian pratincole lacks this comb. The bill is short, broad at the base, and pointed at the tip. The plumage is generally dull brown with white underparts and a white rump. The commonest species, called simply the pratincole, has a creamy throat edged with black. The base of the bill is shiny red and the rest black. The black-winged pratincole differs only in having black underwings. The white-collared pratincole is sooty-brown except for a white collar and rump.

The six species of pratincoles live in Africa, Asia, Australia and southern Europe. The pratincole and black-winged pratincole occasionally wander into western and central Europe, including the British Isles.

Mass landings

Pratincoles live in open and often very desolate country, on the edges of marshes, estuaries, plains and deserts. They have a very buoyant flight and, with their long wings and forked tails, look very much like terns. Pratincoles live in flocks, usually near water, feed together, flying to and fro after insects in a dense cloud. In the evening, especially, members of the flock call to each other with a pleasant trill-like song. When a flock settles they land packed together, all facing in the same direction. As they alight each bird stands for a few moments with its wings held stretched above its back. When they have folded their wings the pratincoles again remain motionless and even a large flock is difficult to see.

Some pratincoles are migratory: the pratincole *Glareola pratincole* moves from Asia to Australia from December to March; others merely make local movements in search of suitable living conditions.

Flying insect net

Pratincoles live on insects: primarily grasshoppers, crickets, locusts and many kinds of beetles. Flies, dragonflies, bugs and others are also taken. In Africa pratincoles are known as locustbirds from their habit of following swarms of locusts. One black-winged pratincole was found to have 175 locusts in its crop.

✓ Take a walk along the river Zambesi. The flocks begin to feed, emitting high pitched screams.



Pratincoles sit tight on the ground but pratincoles typically hawk for insects in the air. Then short, triangular bills open to catch the insects which the insects are quickly 'netted'.

Dancing pratincoles

Pratincoles breed on small islands in lakes, on sandbanks in rivers, on mudflats or in deserts where their nests are fairly safe from enemies. These sites are not usually permanent and clutches may be destroyed by floods. Breeding grounds also vary from year to year. Several hundred pairs may nest together in loose colonies, each pair staking out a territory, around the nest. Intruding neighbours are threatened by lowering the breast to the ground with wings spread or half held out and tail raised. Sometimes communal displays take place on neutral ground. Several pairs gather and take part in a display where each couple bows to the other with tails raised, bobbing then flapping or beating against each other.

Nesting takes place after the rainy season. The nest is no more than a scrape in the ground and sometimes a hoofmark or a simple impression. Between three, sometimes four, eggs are laid and incubated by both parents. During the day the efficiently camouflaged eggs may be left to be warmed by the sun and when very hot the parents may shade eggs or chicks with outstretched wings. The chicks, which hatch out after 17–18 days, are at first fed by the parents and begin to feed themselves when about a fortnight old. They can run almost immediately and start to fly when three weeks old.

Pretended massacre

When approached on the nest pratincoles sit tight. Then, when dislodged, they fly to and fro calling. They also resort to distraction displays which are all the more impressive because a number of pratincoles display at the same time. The display takes the form of 'butterfly wings' and descriptions have been given of mass displays in which 20 or so pratincoles fluttered to the ground, thrashing about with one or both wings trailing, presenting a pitiable sight as if a shotgun had been discharged into the flock. No doubt the sight is sufficient to distract any predator from looking for the well-camouflaged eggs and chicks.



class	Aves
order	Charadriiformes
family	Glareolidae
genera & species	<i>Galachrysa nuchalis</i> collared pratincole <i>Glareola pratincola pratincola</i> <i>G. nordmanni</i> black-winged pratincole <i>Stiltia isabella</i> Australian pratincole, others

◊ Among the daisies—pratincoles do not build a nest, but lay their eggs in a shallow hollow in the ground, a hoof mark or even a dry cowpat.

△ Though pratincoles usually feed in the air they will visit short burnt off grassveld to feed on insects normally hidden in the long grass.

▽ A harassed pratincole gets ruffled as an intruder approaches its eggs in a field of grass and *Salicornia*.





Jane Burton Photo box

- 1. Common grasshopper the deep—carefully cleans an antenna with one of its thoracic limbs.
- 2. Leander, a common grasshopper, plays at long of the castle on a rock as barnacles feed below.
- 3. Possibly present—the bandmarked *Periclemenes brevicarpalis* is a tropical type found in
- 4. *Periclemenes* with the *Discosoma*. Other animals associated with *Discosoma* have similar
- 5. *Discosoma* patterns. Unfortunately, the significance of the pattern and the relationship is not yet known.



Peter Hill

DAI Camera



Prion

Prions are birds of the open ocean, coming to land only to breed. Small relatives of the fulmar (p 833), there are about 10 species all living in the southern oceans. They are slate grey above and white underneath, with a prominent white stripe above the eye and a dark patch just below the eye. The upper surfaces of their wings are darker than the body and appear as a 'W' when prions are in flight. The bill has the tubular nostril, typical of the petrel family which includes the albatross, and in two species is fringed each side by a row of lamellae like a short-toothed comb. The tail is wedge-shaped. The legs and webbed feet are pale blue.

The largest prion is the broad-billed prion, 12 in. long. The bill has a black tip, the lower half having a black line running along the side. It is very broad at the base, like the bill of a frogmouth

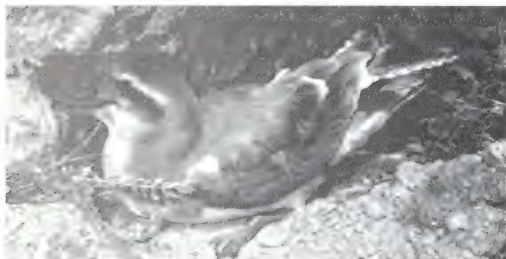
they flick from side to side exposing their white bellies. They are often seen from ships in southern seas but they appear to be less common than they really are because their dull plumage blends so well with the sea, especially in Antarctic seas where visibility is often poor. The non-breeding season is usually spent well away from land and, apart from some shore feeding species, they are seen only in winter when storms blow them towards land.

Filter feeding

Prions congregate to feed where upwellings or mixing of the sea cause an abundance of planktonic animals and plants. The various species of prion appear to feed in different places, each exploiting a different source of food which prevents competition.

Food is picked out of the sea either by short dives, in which they submerge completely, but not for such a long time as diving petrels (p 644), or by ducking the head and neck under the surface. This last they can do either while sitting on the water or while 'hydroplaning', running over the

▽ Broad-billed prion outside its nesting burrow.



like a frog-like appearance. At the other end of the scale is the fairy prion, 9½ in. long, and the narrow-billed prion. The different species of prions cannot be distinguished on flight, and in the hand the main difference is in the shape of the bill.

All species (except one) are confined with the blue petrel *Halobaena caerulea*. The prions have wedge-shaped tails with black edges to the central feathers while the blue petrel has a square tail edged with white.

Prions breed from the coasts of Australia and New Zealand to Cape Denison on the mainland of Antarctica due south of New Zealand. They are also found on the islands surrounding Antarctica, and as far north as Tristan da Cunha and Chatham Island. Outside the breeding season they fly northwards, occasionally reaching Madeira and Indonesia.

Ocean flocks

Prions travel in flocks over the ocean, flying swiftly and sometimes showing up well as

water with wings stiffly outstretched. Two species of prions are known to scavenge as seabirds and they are well named because the lamellae on the bill act as strainers in the same way as the whale's baleen plates. They take in a mouthful of water then squeeze it out between the lamellae leaving any plankton behind. The shape of the bill appears to be important in the separation of feeding habits. In New Zealand waters, for instance, the broad-billed prion feeds mainly on minute organisms. The lower part of the bill is pouch-like, and drops down allowing a large mouthful of water to be taken in, like the lowering of the floor of the mouth by a blue whale (p 248). The narrow-billed prion, on the other hand, feeds on crustaceans up to 1 in. long, which can easily be taken with its narrow bill.

Nesting in burrows

Prions nest in burrows that they dig in the soil, under tussock grass or in deep banks of mossy peat, but where the soil is scant or missing, they nest in crevices or under boulders. The burrows, up to 6 ft long, are dug with the feet being used to kick the loose soil out.

Nesting begins in the spring when the prions start visiting their old burrows or digging new burrows at night. At this time the air around the cliffs and slopes where they breed is filled with a continuous chorus of dove-like cooing as courtship takes place. After mating and digging the females leave the burrows for a few days for intensive feeding, extra food being needed to build up the single large egg. The egg is usually laid the night they return from feeding and is incubated for about 45 days, each parent sitting for 3–4 days at a time. The chick starts life as a ball of light grey down and is brooded for 3–5 days. When it is hungry it nibbles a parent's breast feathers and calls in high-pitched cheeps. The parent then regurgitates food and the chick puts its head in the parent's mouth to take it. The chicks leave the nest when 6–7 weeks old.

Dug out or frozen in

The main enemy of prions is the skua, the large gull-like predator, which feeds on penguins (see adie penguin p 15), and other sea birds. It is unlikely that it catches many prions in flight, but waits for them as they land and shuffle towards their burrows. Skuas also dig open the burrows to get at adults or chicks and the ground around a skua's nest may be littered with bones and feathers—the remains of prions.

In the Antarctic prion eggs and chicks are often endangered by the weather. If a snowstorm covers the burrow the parents can dig down to it, unless repeated thawing and freezing have left a hard crust over the entrance. Some burrows are liable to be filled with drift snow or melted water, which kill eggs and chicks by freezing.

Ideal colouring

In the First World War the American naval authorities were looking for suitable colours to paint warships to make them hard to detect by submarines. They wanted to find a colour that merged well with sea and sky. Robert Murphy, the American expert on oceanic birds, pointed out that prions seemed to have the ideal colouring, but the authorities decided to find a suitable colour by experiments. They eventually found the best camouflage colour was 'Omega grey'. Murphy then asked them to analyse the colours of the dove prion's plumage. It was almost identical with 'Omega grey', with a wavelength of 485 mμ against 'Omega grey's' 486 mμ. Whatever else can be seen from this story it shows that the difficulty of seeing prions as they flit over the waves is not just an optical illusion.

Class	Aves
order	Procellariiformes
family	Procellariidae
genus & species	<i>Pachyptila belcheri</i> narrow-billed prion <i>P. desolata</i> dove prion <i>P. turtur</i> fairy prion <i>P. vittata</i> broad-billed prion others



Unspectacular adults that have remarkable larvae, male (above) and female processionary moths, *Thaumetopoea pityocampa*. Note the male's plume-like antennae. In most moths these are used to locate the females, being sensitive to extremely low concentrations of the scent given off by the females (1-4).

Processionary moth

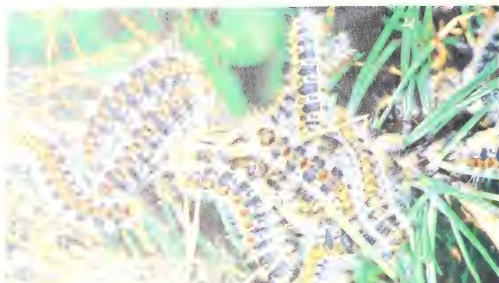
Also known as processional or procession moths, it is the caterpillars of these moths that have stolen the limelight. The caterpillars form processions which almost every writer on the subject has been so taken with that he has failed to say anything about the moth itself.

There are two species in southern Europe, the oak processionary and the pine processionary, and others in the Old World. The male of the oak processionary

moth is just over 1 in. across the wings, the forewings brown-grey with dark bars, the hindwings grey with indistinct dark bars. The female 1½ in. across the wings is lighter in colour. Both rest on bark during the day with the wings folded and fly among the tops of oaks at night from August to September. The eggs are laid on the trunks of oaks and the following late spring the caterpillars hatch out. They are dark bluish-grey, whitish on the sides with rows of rusty-red hairy warts on the back and they grow to 1½ in. The caterpillars spin a communal web, usually

at the base of a tree, and go out at night in a procession to feed on the oak leaves. They pupate at the end of June in the communal web, the brownish pupae forming tight groups.

The pine processionary moth is similar but 1½ in. across and is on the wing from May to July. The eggs are laid on pines. The caterpillars are 1½ in. long, greyish-green with a dark back stripe and yellowish-red warts. The caterpillars cluster by day but have no permanent communal nest and they pupate individually deep in sandy soil.



△ Gathering of pine processionary caterpillars. These larvae feed on pine shoots, sometimes to the extent of becoming a pest.

▽ In orderly troop of *Ochrogaster lunaris*. It is from this unusual 'follow-my-leader' habit that the adult moth gets its name.



Round and round interminably

The habits of the processionary are best illustrated by the well-known story told by the famous entomologist JH Fabre. He persuaded the leader of a line of caterpillars to walk onto the rim of a tub (an experiment). When enough caterpillars were on the rim to form an unbroken circle, he removed the rest and to his amazement the trail of silk they had left behind steadily marching round and round the rim, the head of each touching the rear end of the one in front, the caterpillars continued for 8 days until some of them either from exhaustion or accident fell from the rim and the spell was broken. They had circled 375 times, stopping at intervals for a rest.

Two kinds of processions

The pine processionary travels in a single line and is, as many as 300 have been counted stretching for 40 ft. The oak processionary travels in shorter troops with a single leader followed by two, then three and so on to make a wedge-shaped column. Each caterpillar lays a strand of silk as it goes, so the

trail is marked by a substantial carpet of silk. This was the trail Fabre removed. It used to be thought that in some way the silk helped the caterpillars follow each other. This proved not to be so, although the silk trail is used for returning to their communal web. Since the caterpillars are blind and are said to lack a sense of smell it is reasonable to suppose they merely have the impulse to push the head against the rear end of one of their fellows. If one of them is pushed out of line the whole procession stops until that one is back in its place, then all set off again. Apparently there is no question of a leader. It is quite accidental which one starts the procession, and any one of the column can take a leader.

Nettle-backs

At first glance it would seem that this extraordinary behaviour must be the caterpillars' open to dangers greater than usual. They have, however, very subtle defences. First, as we are told, they are sensitive to approaching storms and all make for their home soon. Secondly, they have a wide sin-

prise in store for living enemies. Along the back each caterpillar has 'mirrors' normally hidden by folds of the skin. These are the warts. When the caterpillar is alarmed the folds are withdrawn and the mirror is exposed. Its surface is covered with nettle-hairs, short hollow bristles with poison glands at their bases. Around each mirror are longer branched bristles which, when touched, brush against the nettle-hairs breaking them away from their moorings so they form a sort of poison dart: one of the many examples of chemical warfare in the animal kingdom. These tiny poison darts produce an intense skin irritation.

Breaking up the procession

In a letter to *African Wild Life* of September 1958, Brian B Hobbs described an adventure just north of Satara, South Africa. He saw a line of caterpillars crossing the road, each light brown, hairy and 1½ in. long. Before he realized they were there he had driven over them. 'Those on the passenger side of the car continued moving into the grass, while those between the wheels remained where they were; those on the driver's side also ceased moving forward. In each case the leader of the last two groups kept nosing about, trying to regain contact with his fellow in front, who had been obliterated. His hind-quarters remained rigid and those caterpillars behind him remained quite still. It would appear they are all blind...' Hobbs remained on the spot for 20 minutes and the two leaderless sections still had not moved forward.

Meaningless circles?

The habit of the processionary moth caterpillar may seem odd to us. Indeed, to see a circle of these caterpillars moving endlessly round and round is one of the most comical sights imaginable. Yet in spite of the kind of hazard Mr Hobbs described, the follow-my-leader behaviour must have great advantage to the species. For one thing, by using the silk trails they lay down, and by following each other, these caterpillars are sure of reaching their feeding grounds and of returning to the security of their communal web after feeding. But what are we to say of the nymphalid butterfly *Atella phalaena* of Mauritius which flies in immense numbers to the east across the mountain Trompsburg, then around the foot to the starting point in an endless ring that has no beginning and no end. Alexander B Klotz, the American entomologist, remarks that this makes less sense than Fabre's processionary caterpillars—this is an understatement.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Notodontidae
genus	<i>Ochrogaster contraria</i>
& species	<i>Australian processionary</i> <i>Thaumetopoea pinivora</i> <i>pine processionary</i> <i>T. processionae</i> <i>oak processionary, others</i>

Pronghorn

The pronghorn is the sole living representative of an ancient family that arose and developed in North America. Usually called the pronghorn antelope, it is not a true antelope, all of which are found in Asia and Africa. It stands $3\frac{1}{2}$ ft at the shoulder and is $4\frac{1}{2}$ ft in length with a 4-in. tail. Bucks weigh about 140 lb., does 105 lb. The upper parts of the coat are reddish-brown to tan with a black mane and the underparts and rump white, with two white bands across the neck. The colour of the coat blends in well with its surroundings. It has large eyes, long pointed ears and a habit of allowing the lower lip to droop on one side giving it an odd expression. The buck has a black face

and a patch of black hair on the side of the neck, characteristics which are less pronounced or missing in the female. Both sexes carry horns, which in the male are longer than the ears, consisting of a permanent, laterally flattened bony core, as in true antelopes, covered by a sheath of fused hairs. Like the antlers of deer they are shed annually, at the end of the breeding season, the bucks losing theirs first, the does shedding theirs a little later. The horns are erect, backward curving, and may be up to 20 in., averaging 15 in. The pronghorn gets its popular name from the short forward-pointing branch which is really part of the sheath, arising from the upper part of its horns.

The pronghorn lives in rocky desert and grassland to forest in Canada, the western United States and northern Mexico.

Venetian blind ventilation

The pronghorn can leap 30 ft at one bound. It is the swiftest mammal of the New World and crosses it at a speed of 40 mph, and it is said to reach a speed of 50 mph over distances of up to 1 mile. The woolly undercoat is covered by long, coarse guard hairs which can be maintained at different angles by the drawing of certain skin muscles. Cold air is excluded when the hairs lie straight and flat, but these can be raised to allow air movements to cool the skin in the heat of the desert sun. Carotid glands pads on the hooves, particularly those of the forefeet, act like foam rubber soles, helping the pronghorn to travel quickly, as well as quickly. The forefeet are used to scrape holes in which to deposit droppings and to dig for food in snow-covered ground.

Consistent behaviour: buck pronghorn antelope





Winter nomads

grasses, shrubs, cactus, and agaves, and can if necessary get all their moisture needs from this diet, although it will drink freely if available. The first breeding season usually begins in September, and the doe usually mates with one or two males. The young are born in May or June, and the doe usually nurses them for about a year. The young are born in small groups, but several may be born at once, and the doe usually nurses them for about a year.

Solitary birth

The rut begins in late summer when the males begin to challenge the males. When the rut begins, the males form a small group of up to 10 males, and the females form a small group of up to 10 females. The rutting takes place in the

season lasting 2-3 weeks. For a first birth there is normally a single fawn, but in later births twins or more rarely triplets are born. They are born after a gestation of 250-260 days. The doe seeks solitude for the birth in open country with low vegetation. Young pronghorns are born with a heavy, greenish coat, can walk within a few hours of birth, and start grazing after 3 weeks. The coat breaks up the light, making the fawn almost invisible. By the age of 3 months the first adult-like coat has grown out, and at 15-16 months the does will mate, although the bucks probably do not until about 2 years old. Pronghorns can live up to 15 years.

White for danger

The main enemy is the coyote, especially in winter, for pronghorns cannot move quickly through snow. Bobcats will sometimes take the young. When danger threatens the horns of the white rump patch are raised, alerting other pronghorns. This white flash can be seen by more than 2 miles away, and pronghorns have excellent distance vision. They are also very curious and will often approach an unfamiliar object, if not startled by a sudden movement or alarmed by its scent.

Curious pronghorn

The family Antilocapridae dates back 20 million years to the middle Miocene period in North America when the pronghorn

population is estimated to have been 40 million. Hunting, for sport, trophies and meat, greatly reduced their numbers, which fell to 30,000 in 1925. Today, however, due to a policy of careful conservation, they are on the increase, the present population standing at about 400,000. Their acute inquisitiveness was noticed by the first pioneers who saw them, and this was to a large extent the pronghorn's undoing. It will inspect any moving object such as a bush waving in the wind, or anything unfamiliar such as dogs, goats, cattle or even machinery. An early trick used to attract the pronghorn was to push a stick into the ground and tie a white handkerchief on it which flapped in the wind. A man lying on his back and waving his legs in the air provided a similar attraction for bringing the pronghorn within gunshot. It seems that the pronghorn has learned its lesson. Today it may be just as inquisitive, but it satisfies its curiosity from a greater distance and is always ready to bolt at the slightest alarm.

class	Mammalia
order	Artiodactyla
family	Antilocapridae
genus	
& species	<i>Antilocapra americana</i>

Winter wanderings: white-rumped pronghorns search for food in the snow-covered ground.



Ptarmigan

The ptarmigan, 14 in. long, is distinguished from other grouse by its white wings and white underparts. There are three plumages—in spring and summer the cock has the upper parts mottled brownish-yellow and grey, the hen being more yellow with black markings; in autumn both are greyer, the hen being still lighter than the male, and in winter both are white all over except for the black tail, and the cock has black eye patches. The young ones have the parents' summer plumage except for dark primary flight feathers. The red wattle over the eye is larger in the male.

Ptarmigan range across northern Scandinavia, Siberia, Alaska, Arctic Canada, Greenland and Iceland with isolated populations in the Scottish Highlands, Pyrenees, Alps, Japan and Newfoundland. The willow ptarmigan, or willow grouse, is a related form with a more southerly range, in the lowland areas of Eurasia and North America. It sometimes interbreeds with the ptarmigan in the wild. The white-tailed ptarmigan is found in the Rocky Mountains, from Alaska to New Mexico, and is very similar to ptarmigan, often living alongside it but not interbreeding so is a distinct species.



Life among the rocks

Ptarmigan live among rocks with scant vegetation in 2,000 ft or more of mild severe habitats than their genetic kin, grouse. When flying they use air-lumps and flip into hollows and lean steep up or down a precipice with equidistance. The cock or hen with a rounder back and then tail down, often with a rolling gait, a bushy tail, the cock is more inclined to strut. When alarmed they crouch, then ptarmigan bounding with the ground, and only fly when danger is imminent. They scratch and dash like other gamebirds and roost in loose flocks. Family parties keep together until the autumn when several may come together forming fairly large flocks. In winter ptarmigan burrow in snow. The calls, a cough or croak and a ringing shrill

and, white surface, as if like a hawk being towards darkness (immature), the female has such less—an attitude.

In summer they feed mainly on the early morning and in the evening, on snows, berries and seeds of seedlings, increased, sprouts, grass, mountain herbs and roots, and carrot. Berries eaten, some bilberry, huckleberry, and similar berries and a certain amount of insects are also eaten. The ptarmigan increase their sexual shoots than the slightly larger willow ptarmigan, and, as more robust fall.

At the height of fashion, a cock willow ptarmigan, in his new spring outfit, a beautiful bird, ptarmigan have three plumages each year: one for spring and summer, one for autumn and one for winter.



Father only keeps watch

In spring the males display to the females by springing into the air with a sort of belching call, then dropping to the ground on outspread wings. They also chase the females with wings drooping and tail raised. The female makes the shallow scrape which serves as a nest among the

litter with a few pieces of grass. In this nest 5-9 eggs, or as many as 16 at times, are laid at the end of May, at 24-48 hour intervals. They are pale yellowish-white with dark red or chocolate blotches. The hen alone incubates, when the clutch is complete, for 21-26 days, the cock keeping

the chicks brooded by the male, (see p. 11).

Distraction displays

The ptarmigan's unusual distribution, all around the Arctic with scattered populations on mountains farther south, is like that of a relict species. Whether they were able to survive the Ice Ages, in places as far north as Greenland, is impossible to say but they are clearly adapted to life in very cold climates. Their presence on the tops of the Pyrenees, Alps and other mountainous areas suggests they were widespread over the northern half of the northern

hemisphere during an Ice Age and retreated north and up into the mountains as the ice cap retreated in the Interglacial period, when the warm climate spread north. The whiteness of the plumage, especially the winter plumage does more than serve as camouflage. It lowers the heat loss from the body. In winter the ptarmigan's ability to burrow under snow, and its possession of heavily feathered toes, acting as snowshoes, indicate that the species is adapted to cold conditions. Finally, there is a record of ptarmigan living at latitude 83 degrees 24 minutes N, in northern Greenland where it would have to endure 72 F of frost.

Ice Age relicts

The ptarmigan's unusual distribution, all around the Arctic with scattered populations on mountains farther south, is like that of a relict species. Whether they were able to survive the Ice Ages, in places as far north as Greenland, is impossible to say but they are clearly adapted to life in very cold climates. Their presence on the tops of the Pyrenees, Alps and other mountainous areas suggests they were widespread over the northern half of the northern

class	Aves
order	Galliformes
family	Tetraonidae
genus	<i>Lagopus lagopus</i> willow ptarmigan
& species	<i>L. leucurus</i> white-tailed ptarmigan <i>L. mutus</i> ptarmigan

Alaska, but this pair of white-tailed ptarmigans, male on the left, manage to merge well with their rocky surroundings.





From winter plumage and feather gaiters to summer tricolors in green, yellow, and red. Some travel in all the seasons, others only in summer.



Puff adder

There are 8 species of puff adder in Africa and they range in size from the Perring's desert adder, 1 ft long, to the Gaboon viper, 6 ft or more long. They are stout bodied snakes with short tails.

The head is very broad compared with the neck, and is covered with small overlapping scales. There is a deep pit of unknown function above the nostrils, and in many species one or more erectile scales on the snout form 'horns', as in the rhinoceros viper. Not all puff adders are given this name, although they all belong to the same genus, and they fall into two groups. There are the highly coloured Gaboon viper and rhinoceros viper, of the tropical African forests, and the sombrely coloured brown and grey puff adders of the savannah and deserts. One of this second group, the common puff adder, is yellow to brown with darker bars or chevrons on the back. It ranges from Morocco southwards across the Sahara to the Cape and is also found in Arabia. The others have less extensive ranges, the Cape puff adder, for example, being found only in the mountains of Cape Province, South Africa.

Melting into the background

Savannah and desert puff adders, with their duller colourings, tend to harmonize with the differently coloured soils on which they are living. So also do the Gaboon and rhinoceros vipers in spite of their bright colours, for their colour patterns are disruptive. The Gaboon viper has a gaudy pattern of yellow, purple and brown arranged in geometric forms. The rhinoceros viper, even more brilliantly coloured with more purple, and blue as well, has green triangles margined with black and blue on its sides. But both snakes are virtually invisible on the carpet of dead and green leaves on the forest floor. The smaller species of puff adder live on sandy soils. Several of these smaller adders are able to climb into bushes, but generally puff adders keep to the ground, hunting mainly during the night.

Inoffensive yet deadly

The broad head of the puff adder houses the large venom glands and although the effect of this snake's bite is less rapid than that of a mamba or a cobra it is just as deadly. Fortunately, these snakes strike only to disable prey or in self-defence, and need a fair amount of provocation to make them hit back. Africans are said to be more afraid of harmless geckoes than of the Gaboon viper, and Herbert Lang tells of a small boy dragging a 5ft live specimen into his camp to sell it to him. If their venom is slow-acting it is nonetheless potent. R Martin Perkins, curator of reptiles in the St Louis Zoological Gardens, nearly died from the bite of a Gaboon viper. Some years later, in 1964, the Director of the Salt Lake City Zoo died from a puff adder bite received while handling the snake. Puff

adders can give out as much as 15 drops of venom at a time—4 drops are enough to kill a man. But usually snakes give a first warning by hissing. The hissing sound is produced by forcing air from the lungs and windpipe through the glottis. Puff adders have an especially loud hiss. Their puff makes a sound more like the noise of a horse when it forces air through its lips.

Beckoning their food

The food of puff adders varies widely between the species. Small prey, such as a frog, is grabbed and swallowed without being poisoned. Larger prey is struck with the fangs and allowed to run away to die. The snake later follows its trail to eat it. The carcase is dragged into the snake's mouth by the teeth in the lower jaw. Once part of the victim has reached the throat, muscular swallowing movements carry it down, the snake holding its head up to assist this. Some scientists claim that the long fangs, which may be 2 in. long in a 5ft Gaboon viper, are used to drag the victim into the snake's mouth. South African herpetologists do not support this, but suggest the long fangs make it possible to inject the venom deeply.

The common puff adder and the Gaboon viper eat rats and mice, ground-living birds, frogs, toads and lizards. The Cape Mountain adder feeds on the same but is known to eat other snakes. The many-horned adder and the horned puff adder bury themselves in the sand, except for the eyes and snout, to catch lizards. The horned puff adder leaves the tip of its tail sticking out of the sand and waggles it to attract its victims within striking distance.

An enemy to many small animals, the puff adder has few adversaries itself, mainly birds of prey, mongooses and warthogs, and man. Puff adders can store large quantities of fat and this is sold by African herbalists as a cure for rheumatism.

Large families

Puff adders are ovoviparous. That is, the eggs are hatched inside the mother so the young are born alive or else they wriggle out of the egg capsule soon after it is laid. Mating is usually from October to December, the young being born in March and April. The young from a mother 3 ft long, are about 8 in. at birth. There are 8–15 in the litter of the smallest species, 70–80 or more in the large puff adders.

Fasting to grow

The paradoxical frog (p 1698) is so named for the paradox that the tadpole is much greater than the froglet into which it changes. The puzzle is, where does all the spare flesh go? The situation is reversed in the baby puff adder. As soon as it is born it can kill and eat small mice although it moults first before looking for food. It can, however, happily go without food for as much as 3 months. The ability to fast is not unusual. What is extraordinary is that the baby puff adder still grows 25% in length and increases its girth by a quarter while doing so.

▷ The attractive 'horned' head of the rhinoceros viper is deceptive; it houses the venom glands!







Anthony Bannister, NHPA



△ Sedate mating, two lovelocked common puff adders, the male is on the right. Mating usually takes place from October to December. Fertilisation is internal and sperm may survive inside the female for long periods. Most reptiles lay their eggs but puff adders are ovoviviparous, the female retains the eggs until the young are ready or nearly ready to hatch, 5–6 months later.

◁ Submerged for the day, a small Perringuey's puff adder spends the day well hidden. Halted by the photographer the snake raises its head so giving its position away. But its sandy colouring blends well with the soil making the snake very inconspicuous.

class	Reptilia
order	Squamata
suborder	Serpentes
family	Viperidae
genus	<i>Bitis</i> arrietans common puff adder
& species	<i>B. atropos</i> Cape Mountain adder
	<i>B. caudalis</i> horned puff adder
	<i>B. cornuta</i> manchothead adder
	<i>B. gabonica</i> Gaboon viper
	<i>B. inornata</i> Cape puff adder
	<i>B. nasicornis</i> rhinoceros viper
	<i>B. peringueyi</i>
	Perringuey's puff adder

Puffbird

Their stout appearance, reminiscent of a puffin, and the loose, fluffy plumage of puffbirds has given them their aptly descriptive name. In Brazil they are known as *João bobo* or Silly John in reference to their stupid appearance and sluggish habits, for they are very easy to approach. They are related to the woodpeckers and jacamars, having two toes on each foot facing backwards. The 30 species range from sparrow to jay size. The head is large, the bill hooked and the tail short.

Most puffbirds live in the Amazon valley and surrounding low country, but three live north of Panama. The white-necked puffbird ranges from Mexico to the Amazon. It is 9–10 in. long, mainly black above with white underparts, forehead and collar and with a broad black band across the breast. Most puffbirds are, however, brown or grey with streaks and speckles. The white-whiskered softwing is a little smaller and ranges only as far south as Ecuador. It is chestnut-brown with tawny underparts, turning white on the belly, and a white patch on either side of the bill like a drooping moustache. The female is duller than the male. The swallow-wing has a similar build to these puffbirds but has long wings. It is like a stout swallow, about 6 in. long, and almost black with a white rump. Another group of puffbirds are the nunbirds, nunlets or monklets, so-called because of their plain dull brown and grey colouring, whose only relief is a bright orange bill.

Puffbirds live in forests, in low lying country. Some are found well up mountains living alone or in small groups. The nunbirds travel in small flocks.

Tied to a perch

Puffbirds appear very lethargic, perching motionless with their feathers puffed out, but they are in fact alert and pounce on any insect that appears. The swallow-wings can usually be seen sitting in pairs, on the bare branches of tree tops, from which they launch graceful sorties against insects.

Puffbirds are usually silent, uttering no more than a few soft whistles and peeps. They are very unwary, and will perch in exposed places, refusing to fly far if disturbed, as they often become very attached to their perches, sometimes using them year after year.

Snatching meals

The usual feeding method of puffbirds is to fly out from the perch, catch an insect and return, but they also snatch small animals from leaves and branches and a few descend to the ground for their prey. On returning to the perch the catch is pounded against the branch before being swallowed. Puffbirds' main food is large insects such as butterflies and locusts, spiders and sometimes lizards. They have been recorded as catching lizards as large as themselves.



White-necked puffbird photographed in Panama. The sharp hooked bill is typical of birds feeding on large insects and other small animals.

Underground nests and aerial nests

Puffbirds nest in holes which they burrow in the ground, or in the nests of tree-dwelling termites. The male and female black-breasted puffbird take turns to excavate a tunnel in a termite mound suspended on a bough. The tunnel is about 7 in. long, 2 in. diameter, and widens into a nest chamber. The termites seal off their galleries from the puffbirds' tunnel so they leave each other alone.

Other puffbirds that have been studied make their burrows in the forest floor. They usually choose gently sloping ground. The white-whiskered softwing hollows out burrows 18–22 in. long. The nest chamber is lined with leaves and more leaves are placed around the entrance as camouflage. Swallow-wing burrows may be up to 8 ft long.

Puffbirds lay 2 or 3 white eggs which are incubated by both parents, but the incubation period is not known. The white-whiskered softwing has an unusual pattern of incubation. The male sits from late afternoon to the following dawn while the female sits only during the morning, the eggs being left unattended between these periods. The male broods the chicks for a few days while the female does all the feeding. When brooding has ceased the chicks seal the entrance to the nest chamber each night with leaves from the nest lining.

Hidden entrances

The burrow of the white-whiskered softwing is camouflaged with a collar of dead leaves and sticks which blends with the surrounding leaf litter; that of the black nunbird is hidden beneath a large pile of sticks with a tunnel in the side that connects with the burrow. The function of these structures is presumably to hide the nest from predators, for burrows in the forest floor are very vulnerable. Most burrow-nesting birds, such as kingfishers and martins make their burrows in the sides of steep banks where predators have difficulty in reaching them. The habit of the white-whiskered softwing nestlings of blocking the nest entrance is also a protection, as is their habit of keeping quiet and concealed except when being fed.

class	Aves
order	Piciformes
family	Bucconidae
genera & species	<i>Chelidoptera tenebrosa</i> <i>Malacoptila panamensis</i> <i>white-whiskered softwing</i> <i>Monasa nigra</i> <i>black nunbird</i> <i>Notharchus macrorhynchus</i> <i>white-whiskered puffbird</i> <i>N. pectoralis</i> <i>black-breasted puffbird, others</i>

Puffer

variety of other names, such as ballon-fishes, scoffishies, globe-fishes and blow-fishes. All express their outstanding feature, of being able to blow themselves up to twice

related potpourri fish (p 1823). They grow up to a foot or more in length. The body is flattened on the underside, rounded above, when in the normal state, with a large head and large prominent eyes that give an air of perpetual surprise—or of

obsturacy. The dorsal fin is set far back, with the anal fin immediately below it, and these, together with the pectoral fins, are used in swimming. The skin is tough with small erectable spines which take the place of scales. The belly is usually lighter than the back, but in some puffers it is white, while in others the colours of the back extend to the belly with only a slight difference in shade. Those species that live in the open sea are greenish or bluish black on the back. Those living around coral reefs are usually blue or purple brown with white spots, mottling or stripes.

They live in tropical seas, usually in-shore among coral reefs, but several species go well up large rivers such as the Nile and Congo.

Unusual swimmers

Like many potpourri fish, puffers have a very different swimming technique. The old opinion was that they swam by flattening the body, creating a surface resembling a thin, flat plate. But close and intensive studies have shown that this idea for propulsion is neither meaningful, and the defence measure of taking the body in two, two swimming modes, normally limited to the rear half of the fish, is actually the opposite. For three quarters the dorsal and ventral fins are completely developed. A puffer swims by means of the dorsal and the ventral fins, and the caudal fin, and the deep, thin, long, pointed fins. The fish is not so much a puffer.

Probably one of the most important moves in the life of a puffer is the ability to blow. The most striking way in which puffers blow themselves up is by inflating their skin as a means of defence against the water. When in water all puffer fishes are covered in a mucus of water. This mucus is a sticky, slimy, foamy substance that is used to keep the fish from drying out. When a puffer takes an interest in water, he will blow a large amount of water into his stomach, and from there it will be pumped out of his mouth, or from a point of a pump, being capable of considerable expansion and contraction. When inflated, the puffer makes a ball of mucus, and is able to move.

For those who want to know more about *Canthigaster margaritatus*, this small beautiful, coloured fish, with its distinctive blue lines is characterised by its long snout.



▲ The spotted puffer *Sphaeroides dorsalis*, normal size, are otherwise small, defensive fish.



The teeth of a puffer, like those of the

Sharks and barracuda will eat puffers, in

a blue trunkfish *Ostracion lentiginosus*

Puffin

The puffin, a small auk about 12 in. long, with a massive, brilliantly coloured and decidedly bizarre bill, is perhaps the most popular and well known of sea birds. The comical effect of the bill is enhanced by coloured horny patches above and below the eyes. The plumage is basically the same as that of other auks; black above and white underneath, with the black extending around the neck as a collar. The legs are bright orange and the sides of the face ashy grey. The triangular bill has red, yellow and blue stripes with a thick yellow skin in the corners of the mouth. Outside the breeding season the basal part of the horny covering of the bill, including the blue parts and the yellow skin, are shed, leaving the base of the bill narrower and horn-coloured. At the same time the red tip becomes yellow. The bill of young puffins is more conventional, narrower and plainly coloured, the inner half greyish brown, the outer half reddish brown.

The puffin breeds along the coasts of the North Atlantic from Greenland to the Gulf of the St Lawrence in the west and from Spitzbergen and Novaya Zemlya to the British Isles and northern France in the east. Some spread as far south as the Canaries and into the Mediterranean as far as the Adriatic. British puffins have been found wintering in American waters but not all puffins migrate away from their breeding places. Puffins regularly spend the winter in Baffin Bay and in mild winters they stay near Amsterdam Island, north of Spitzbergen, despite the low temperatures and continual darkness of the Arctic winter. The horned puffin, which lives in the North Pacific and is a close relative of the Atlantic puffin, has fleshy growths over the eyes and differs in the colouring of the bill. It breeds on either side of the Bering Sea. Another Pacific puffin is the tufted puffin, all black but for a white face and long tufted feathers sprouting from above the eyes. The bill is red and green.







Comic sea parrots

◁ Captured in a puffin's beak, unfortunate sand eels glisten in the sun as the puffin pauses for a few moments to reflect on the glory of his catch, before flying back to his burrow to feed his young puffin. Puffins swim underwater with their wings while searching for food and are able to hold as many as 30 small fishes in their beaks, although this is rare.

▷ An affectionate peck. These two puffins are engaged in a ritualized courtship ceremony known as billing which may also occur during aggressive behaviour. Once they have mated on the water the puffins journey to a breeding ground where they begin either to dig a new burrow or clear out a disused one.

▽ A colony of puffins enjoys resting on a cliff at Farne Island. When they take off from the cliff the puffins' wings do not seem capable of supporting their squat bodies and they career steeply towards the sea until the rapidly beating wings come into effect and they rise. They spread their webbed feet as they turn corners while flying or coming in to land.



© Russell



© David Beal/Photo Disc



▽ Puffins staggered over the skyline come in to land at the breeding ground. Striking black and white plumage, perched on burrows, these birds are the only ones to be seen in the colony at this time of year.



Cliff-nester

From spring until the end of the breeding season, puffins contribute to the masses of birds that fly continually to and from the cliffs. At first, as puffins on their haunches like other auks such as the guillemots (p. 978), puffins walk easily with a waddling gait. When they take off from the cliffs, however, they appear to be too small to support their full body weight. As they rise, their wings droop, and their bodies become more horizontal. When returning to the cliffs, they are seen to land close to the ground, spread out, and then, after a few seconds, walk.

Mysterious fish stackers

Puffins feed on small fish, such as sand eels, and small fish are the only food source for them in the burrows and other pit-like structures. During the breeding season, they are seen to stack fish on top of each other, one on top of another, in a neat row. It is not clear whether the fish are stacked for the adults to eat or if the fish are stacked for the chicks to eat. Puffins are quite tame on their breeding cliffs and can be watched from close quarters, feeding with fish draped crosswise in the bill. They can carry up to 30 fish in this way, but this is exceptional. How they arrange the fish in the bill is still

a mystery. Presumably, each fish is killed by a snap with the bill, but how it is then placed alongside ones caught previously without dropping them is difficult to visualize. The tongue and the serrated floor of the upper mandible may be used to manoeuvre and hold them. Pictures of puffins with fish arranged in the bill head to head or alternating head to tail are based on either imagination or coincidence. Working the fish into a pattern would be very difficult and would serve no useful purpose.

Slow development

When puffins arrive at the breeding ground they start digging burrows or clearing out old ones. They dig with their heavy bills and scrape the loosened soil out with their feet. In large colonies burrowing can become extensive, as to cause a landslide. Sometimes they take over shearwaters or rabbit burrows.

Puffins arrive at the breeding grounds dressed paired but there is a considerable amount of displaying around the burrows. The large, colourful bill is used as a signal, being thrust forward in threat or shaken in appeasement. Mating takes place on the water after the male has chased the female.

A single-egg white with faint markings is incubated for 40–43 days. The parents

share the task, but at intervals they leave the egg and parade together outside the burrow. The chick is fed on fish by both parents, but when 6 weeks old it is deserted by the parents who go out to sea to moult, during which time they become flightless.

The chick stays in the burrow for another week then flutters down from the cliffs and paddles out to sea. The young puffins leave the burrows at night when there is less danger from gulls and skuas. Until they can fly they avoid danger by diving. Seven weeks is a very long fledging period for an auk, but puffins are reared in the safety of a burrow, whereas guillemots, razorbills and other auks breed on cliff ledges where their chicks are vulnerable to predation by gulls. These auks also leave the nest before they can fly, but unlike puffins are not independent and remain in the care of the adults.

Rat and oil problems

A certain number of puffins fall prey to gulls and skuas; on the island of Foula in the Shetlands, for instance, the cliffs are sometimes littered with the remains of puffins eaten by skuas, but their numbers are more severely reduced when rats are introduced to their breeding grounds. At one time the puffin population of Ailsa Craig was described as phenomenal, but in 1889, rats got ashore from a wreck and the population has since declined almost to extinction. A similar decrease has also occurred on Lundy, the name of this island being Norse for Puffin Island.

Recently there has been another threat to puffins, and other auks. Oil pollution is particularly serious to auks, because of their gregariousness and their habit of diving out of trouble and resurfacing in the oil patch. They are also particularly vulnerable when flightless during the moult.

Cliff crop

Man is another predator of puffins. The islanders of Faeroe, Shetland, St Kilda and other places have for a long time relied on sea birds for food, although the practice has declined in recent years. On St Kilda where sea birds formed the mainstay of the islanders, more puffins were killed than any other bird, including gannets and fulmars.

They were the main food during the summer, eaten roasted, and their leathers were collected and sold. Catching puffins was usually the women's work, assisted by dogs who helped locate nests. They were hauled out of their burrows, snared or caught in nets as they flew in. On Foula, the sheer cliffs where many of the puffins nested were divided so that each man had a section where he could hazardously collect his crop.

class	Aves
order	Charadriiformes
family	Alcidae
genus	<i>Fratercula</i>
& species	<i>fratercula arctica</i> <i>atlantica</i> puffin <i>f. corniculata</i> horned puffin <i>lunda cirrhata</i> tufted puffin

Puma

It is usual to say that this animal is known in Britain as the puma and in the United States and Canada as the cougar. Yet Stanley P Young and Edward A Goldman, American authors, have titled their book on it 'The Puma', and they claim this is the correct name for it. Probably no other animal has received so many common names, another of which is the mountain lion, which gives a clue to the appearance of the puma. It looks like a lioness, its coat is of short close fur and its colour yellowish-brown, although this varies from yellow to red. The maximum size recorded, for a male, was 8 ft long, of which 3 ft was tail, and 260 lb weight, but there is much variation from as little as 4 ft total length and 46 lb weight. The females are generally smaller than males. The puma ranges from western Canada to Patagonia in the southern half of South America, on mountains, plains, deserts and in forests. Although there is only one species, 30 subspecies have been named, based on differences in size and colour, a clear indication how variable these two features are.

Powerful caterwauling killer

The puma is known for its remarkable strength and stamina. It will cover up to 20 ft in one bound and a leap of 40 ft has been recorded. It can leap upwards to a height of 15 ft and has been known to drop to the ground from a height of 60 ft. Like many other members of the cat family, the puma leads a solitary life keeping very much out of sight. A puma will often kill and, holding its prey, toss it over its shoulder and walk away with it; one has been known to drag a carcase three times its own weight over the snow. It will travel 30–50 miles when hunting. Its trail is marked by the remains of prey lightly buried in the ground, and by the scratchings where it has scraped earth over its urine or dung.

Some of its common names, such as catamount, refer to the puma's voice, but there are differences of opinion on how much this is used. Pumas are said to emit blood-curdling screams at times and there have been many vivid descriptions of this. It has been described as a weird caterwauling yell or scream, hence the saying 'to yell like a painter'—another name for the puma. By contrast, game wardens working in puma country for years have remarked on the fact that they have never heard a puma scream. It has even been suggested that people have seen a puma in a tree, for it is a good climber, and at that moment a great horned owl, hidden in the tree, has called and this has been credited to the puma. The evidence suggests that both male and female scream but not frequently. Normally they purr when contented.

A unique and magnificent action picture of a puma making a flying leap to the ground. This cat is renowned for its strength and stamina.



Another aspect of the puma's way of life which is much debated has to do with its attitude towards man. It has been represented as highly dangerous yet sober surveys show that attacks on human beings are so rare as to be negligible. It seems likely that the screaming may have contributed to an undesired reputation for ferocity, together with its habit of stalking people. This seems to arise from an overwhelming curiosity and many naturalists have told how they have been followed by a puma which melts into the undergrowth every

Controlling the deer

Its main prey is deer which may make up 50-55% of its food, and wherever the puma takes a variety of small mammals including porcupines. It sometimes attacks domestic stock, such as sheep and goats, as well as horses and cattle, and it will take carrion. It is reported to be especially attracted to mountain deer and the larger pumas suddenly pouncing on their backs with a powerful stroke of violence that the prey is carried up to 20 ft along the ground. The typical method of killing is by a bite into the throat.

Spotted kittens

Pumas breed the year round. After a gestation of 90-93 days a litter of 1-4 cubs is born; at birth they are blind, and have spotted fur and a ringed tail. The eyes open at 10-14 days and the cubs are weaned at 1-3 months. The period seems to vary, as does the time they stay with the mother, which is up to 2 years. As they mature the cubs lose their spots and the rings on the tail. The lifespan is up to 18 years.



Puma - Felis concolor

Man the merciless enemy

A puma has few enemies apart from man but where their ranges coincide jaguars and pumas often fight. Wolverines will attack pumas and grizzly bears are also credited with doing so. These hazards are probably very trivial compared with man's activities which have wiped out the puma on seriously reduced its numbers in parts of its range. Pumas are killed with traps and hunted especially with dogs which will usually tree the puma putting it at the mercy of the marksman. In some places and at various times bounties have been paid, the main complaint against the puma being its attacks on domestic stock.

Puma: the friend of man

In contrast with the way pumas are persecuted in North America, these animals have been called 'the friend of man'. The origins of this title go back to 1536 when the Spaniards in Buenos Aires were at war with the Indians. A young woman, Senorita Maldonado, was wrongly accused of treachery when, in fact, she had been carried off by the Indians. She was condemned to be tied to a tree to be eaten by wild beasts. After two nights and a day the soldiers went to collect her bones for burial and found her unhurt. She explained that a puma had stayed by her and driven off the jaguars and other beasts that came to destroy her. The Indians of California had even more cause to regard the puma with friendly feelings. The Jesuit priests who went there to preach Christianity to the natives found that for centuries they had largely fed on the remains of the pumas' prey.

class	Mammalia
order	Carnivora
family	Felidae
genus	
& species	<i>Felis concolor</i>

Truce at midtime. Fastidious as most cats are, the puma cleans a paw while the grizzly bear continues to eat the elk. Pumas have few enemies although grizzly bears are said to attack them. In fact the puma is a cowardly cat and a shy animal leading a solitary life hunting deer and small mammals and birds.



Purple emperor

A large, showy and unfortunately rare butterfly, the purple emperor is named after the purple iridescence on the wings of the male, which can only be seen when viewed from a particular angle. Otherwise they are dark-brown, almost black, with a line of white patches and an inconspicuous eyespot on each hind wing. The white patches are very occasionally missing and such purple emperors are known as the variety *iole*, much sought after by collectors. The underside of the wing has an intricate pattern of brown and grey with bands of white. The female is very much like the male but lacks the iridescence and is slightly larger. Her wingspan is 3 in. compared with 2½–2¾ in. of the males.

Purple emperors are found locally in many parts of Europe and Asia. In Britain, they are restricted to a few places in the south.

Two plants needed

Purple emperors' preference for oak woods is one factor which limits their distribution since these woods become scarcer year by year due to man's activities. Purple emperors do, however, survive in woodlands that have been stripped of all tall trees. They are on the wing in July and the first half of August but even in bright weather and in places where they are known to live they are not easy to see. They are not attracted to flowers like so many other butterflies and spend most of their time around the tops of oak trees. The dull coloured females are easier to find because they descend to lay their eggs in sawn bushes. The males spend their time perching on leaves and periodically flying high across a clearing or soaring up almost out of sight on their powerful wings. Sometimes several males may be seen chasing each other in circles.

Slug-like caterpillar

Purple emperors lay their eggs on the upper surfaces of sawn leaves. Each female ranges over a considerable area, laying one egg on each leaf, although she may revisit a bush later and so lay another egg on a leaf already bearing one. Other females may also use that leaf, so it is quite possible to find several eggs on one leaf. The egg is like a minute blanchmange, $\frac{1}{16}$ in. high, almost hemispherical with about 14 radially arranged ridges. At first it is green, then the base becomes purple, and just before hatching it turns black. The caterpillar emerges about a fortnight after the egg is laid. It is yellow with a black head and measures just a little over $\frac{1}{16}$ in.

After 10 days of eating the sawn leaf on which the egg was laid the caterpillar sheds its skin. It is now green, the same colour as the sawn leaf, and it looks very much like a slug, with a pair of horns projecting from the head and a body tapering to a point at the rear end.

The caterpillar continues to feed through the summer and into autumn. It grows to $\frac{1}{2}$ in. and changes to brown, so matching the autumn leaves. When not feeding it lies



along the midrib of the leaf so that it is very inconspicuous. In October the caterpillar retires to a twig or a fork between two twigs, and spins a mat of fine silk on which it rests for the winter. In the following April the caterpillar changes colour back to green, and starts feeding on the fresh leaves, growing to $\frac{1}{4}$ in. before pupating in June. Pupation takes place on the underside of the sawn leaf where it lays a mat of silk and runs more silk up the leaf stem to the twig, presumably to act as an anchor. The chrysalis hangs from the silk mat by a number of small hooks. Just before pupating the caterpillar changes to a very pale green, matching the underside of the sawn leaf, and making the chrysalis very difficult to find. The adult butterfly emerges in about 3 weeks.

Lured to the ground

Although male purple emperors spend most of their short lives in the tops of the trees, they do sometimes come down, feeding on the sap that oozes from wounded trees and sometimes on the honeydew of aphides (p. 90). They also descend to the ground to drink at puddles or to feed on animal carcasses or horse droppings. At one time purple emperors were caught by placing the rotting corpse of a rabbit or other animal in a woodland ride, but this method

Brilliant beauty—a purple emperor settles itself on a spray of oak leaves. This attractive butterfly is unfortunately not very common and is seen even more rarely than one would expect as it spends most of its time at the tops of oak trees. Although it can sometimes be seen on oak plantations, mature oak woods are becoming fewer and fewer.

The butterfly's purple colouring, possessed by the male only, is normally seen on both wings, even this picture. In some lights both wings are iridescent, the purplescales changing colour with the movement of the light. There are actually four distinct iridescent pigments.

is not successful now, probably because the purple emperor has become so scarce. They can also be attracted by bright objects and there are several stories of male purple emperors coming down to settle on car radiators, and even flying 'headlong' into cars as they are being driven along.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Nymphalidae
genus	
& species	<i>Apatura iris</i>

Purple sea snail

Sometimes called the violet sea snail or the floating shell of the high seas, the purple sea snail is one of the most extraordinary of molluscs. It is shaped like a garden snail or a periwinkle, and resembles them both in structure. The body is purple and the shell, blue, lavender, violet or purple, is paper-thin yet not transparent. The mollusc lives more or less permanently upside down. The upper part of its shell, that is the part that is underneath, is whitish, so it is counter-shaded, like fishes with a coloured back and a whitish or silvery belly. The lightweight shell may be up to 2½ in. across but is usually smaller. Judging by the large numbers of them washed up on tropical beaches, purple sea snails live in very large numbers in the warm seas of the Atlantic, Indian and Pacific oceans. Sometimes the dying or dead animals are carried by warm currents, driven by persistent winds in summer, onto shores of temperate seas.

Bubble rafts

The purple sea snail, which forms part of the oceanic plankton, floats more or less permanently upside down at the surface on a bubble raft, which it makes by secreting, from the middle and front part of the foot, a kind of froth which traps the air into bubbles. The tip of this part of the foot is pushed out through the surface film. It closes round a bubble of air, almost as if it were a hand grasping, and brings this down to the middle of the foot to be coated with mucus. Although transparent the bubbles cannot be pricked open, their walls being hard and like a cuticle. After they have hardened they are glued together by having more mucus poured over them. The raft is usually 3–4 times the size of the sea snail.

Feeding on jellyfish

Purple sea snails feed on other animals in the plankton, such as crustaceans and jellyfishes. The crustaceans including stalked barnacle larvae, and the jellyfishes including most notably that known as *Verella*, a relative of the Portuguese man-of-war (p 1828). *Verella* is made up of a colony of polyps hanging down from a plate-like float which is several inches across. On the upper side of the float is a nearly triangular crest, looking like a low sail. *Verella* has been called By-the-wind-sailor or Jack-sail-by-the-wind. We have definite information only about the way the purple sea snail feeds on *Verella*. It clings to the underside of the jellyfish and steadily eats away the polyps and the tentacles with their stinging cells, leaving in the end the plate-like float with its triangular sail to drift on the surface of the sea. These lifeless rafts are not wasted; barnacles often settle on their undersurfaces.

We know they eat copepods, and also another flattened disc-like jellyfish related to *Verella* and known as *Porpita*, as remains of these have been found in their stomachs. They also eat *Halobates*, the only marine insect which is a kind of pond skater. Purple sea snails also indulge in cannibalism, so it seems they just eat any kind of animal they can overpower. They have no eyes, the main sense-organ being a black tentacle near the mouth which may be an organ of smell by which the snails detect the presence of prey.

Table to cradle

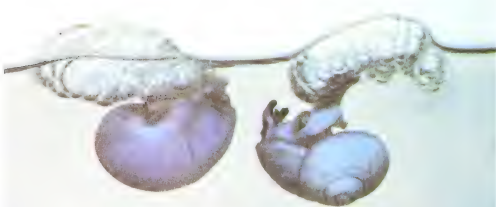
As if to add insult to injury the purple sea snail lays its eggs on the underside of the cleaned-up *Verella*, converting a former dining table into a cradle. Most species lay eggs in capsules which are fixed in rows. They may also be laid on the underside of the bubble raft. The number of capsules may be 300–600 according to the species and the size of the individual laying the eggs. The number of eggs per capsule may be as few as 17 in one species and as many as

5 500 in another. The purple sea snail that most commonly reaches the shores of the British Isles gives birth to live young. These are ciliated larvae, known as veligers, and they are like the larvae that hatch from eggs. One curious feature of the veliger larva is that it has an operculum—like the wrinkle head (see periwinkle p 1737). Most land or sea snails have an operculum throughout their life, but the purple sea snail larva loses it when it changes to a tiny snail and it is not replaced. Young purple sea snails are male at first, becoming female later in life.

Oceanic Borgias

It had been noted a long time ago that while the purple sea snail is feeding it squirts out a violet dye from time to time. The importance of this was not realized until 15 years ago. This dye seems to act as an anaesthetic on *Verella*. Since some of the polyps, as in the Portuguese man-o-war, are digestive polyps capable of fastening onto and slowly digesting another animal, we can presume the sea snail has to numb its prey. There are also the tentacles with their poisonous stinging cells to be reckoned with. Mr Peter David, of the National Institute of Oceanography, caught some *Verella* with snails on them, 500 miles out in the Atlantic. He kept them in an aquarium and watched the feeding. He also found that when *Verella* had been squirted with the purple dye by the sea snail it did not shed its tentacles as it died which is what it usually does. Moreover, when put into a preserving fluid the tentacles did not contract nearly as much as when the *Verella* had not been sprayed. The logical conclusion, therefore, is that the purple sea snail 'puts its victims to sleep' before devouring them.

Finally there is a slight touch of comedy-tragedy. The barnacles that settle on the dead *Verella* raft may be eaten by another purple sea snail. On the other hand the sea snail itself may be plagued by ship's barnacles that settle on its own shell.



phylum	Mollusca
class	Gastropoda
order	Mesogastropoda
family	Lanthinidae
genus	<i>Lanthina exigua</i>
& species	<i>L. globosa</i> <i>L. janthina</i> <i>L. violacea</i>

Life upside down—two living specimens of *Lanthina janthina* float at the water surface attached to their permanent bubble rafts.

The snail and its raft are carried along by sea currents and by the wind. Purple sea snails are often seen feeding in large numbers yet lone individuals seem to find enough of their favourite jellyfish *Verella* to eat, these are 'spared' expertly by the snail's long prehensile proboscis. The snail on the left is shedding a violet dye which is thought to anaesthetise its victims before they are devoured.

Purse sponge

The *purse sponge* is one of the few sponges, apart from the various kinds of bath sponges, to be given a common name. It is relatively insignificant, being usually no more than 2 in. high, although it very exceptionally reaches a height of 6 in., but it illustrates perhaps more completely than any other species the plastic nature of sponges especially in regard to their asexual reproduction.

The creamy white *purse sponge* is sometimes said to be vase-shaped but a better description would be that it is like a brandy glass flattened from side to side with a short stem and a small base. Its outline often departs from this simple form becoming irregular and much folded on itself.

Purse sponges live between tide marks, especially on rocky shores, from mid-tide level to low water spring tides, and occasionally in marshy waters down to 60 ft. They extend all round the coasts of Europe and into the Arctic, more sparingly in the Mediterranean, and in scattered localities in other parts of the world.

Feeding on bacteria?

They live under stones, under bunches of seaweed, between rocks, or in caves or cavities formed by boulders, all situations where the sponge receives dim light and which do not completely dry out even when the shore is uncovered by the ebbing tide. Almost invariably they hang 'mouth' down.

The outer surface of a *purse sponge* is perforated with microscopic pores each leading to a thimble-shaped flagellated chamber lined with collared cells called choanocytes (see bath sponge p.166). Water is drawn in through the pores by the combined beating of the whiplike flagella of the choanocytes, and leaves by the mouth of the thimble into the central cavity of the sponge. From there the accumulated effluents from all the flagellated chambers spill out through the mouth of the 'brandy glass'. In its passage through the sponge the water gives up oxygen, and fine particles trapped inside the collars of the choanocytes are absorbed. How this is done and how food material is distributed throughout the body of the sponge is not known. Furthermore, we can only guess at the type of food eaten. One of the clues to guide us is that large *purse sponges* are found in estuaries and harbours where the water is heavily polluted with sewage and garbage. We have to assume therefore that the food of a *purse sponge* is either composed of very minute plants and animals or microscopic particles from dead plants and animals or bacteria. Possibly it feeds on all these. There is little doubt, however, that all sponges, like other particulate feeders such as the mussel (p.1548), are scavengers which help to purify the water they live in.

The *purse sponge* has a skeleton of calcite spicules. The spicules have three rays (triradiate) to which a fourth ray is sometimes added (quadriradiate) and some are needle-shaped rods (monaxons). They are

arranged in a fairly constant pattern in the skin and around the flagellated chambers and probably serve to support the tissues.

Sex without sex-organs

Purse sponges are hermaphrodite, males and females being produced by each individual. There are no special reproductive organs but in some corners of the body cells become smaller with food granules and increase greatly in size. At the same time other smaller cells migrate through the pores and arrange themselves around each enlarged cell to form a capsule enclosing it. Some of the enlarged cells become ova while others divide repeatedly to form a mass of small cells which are the sperm. The fund is later liberated by the breakdown of the capsule. They are carried into the surrounding water by the outgoing current and so

to another *purse sponge*, entering it on the ingoing current and fertilising the ova in it.

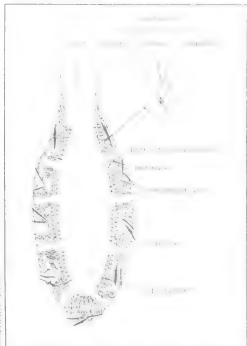
The fertilised ovum subdivides repeatedly to form an egg-shaped mass of very small cells. These of the smaller end throw out whiplike flagella. These begin to beat the fore-and-aft, and then burst from its capsule and sail out to the exterior. Each flagellate swims about for less than a day, then the flagella are withdrawn. Within them the larva sinks to the bottom and settles to start life as a new *purse sponge*.

Eaten by winkles

It has been thought that *purse sponges* have no enemies. Since they feed on bacteria and other germs they are actually free of disease. In fact the only known disease of living *purse sponges* is a fungus and the enemies are surprisingly few. Usually molluscs. One mollusc, the round periwinkle, sometimes eats holes in the *purse sponge*.

Multiply by fragmentation

The *purse sponge* used often to be shown in textbooks as a line drawing of a simple pouch, somewhat vase-shaped, and always the wrong way up. The smaller individuals have a simple outline but in the majority the body is folded on itself in various ways or it has holes in it or several secondary vascles around its margins. These shapes represent the various ways in which the sponge reproduces asexually. For example, at one point on the surface of the sponge a lobe grows out and the lobe so formed folds over onto the body. A line of weakness develops along the fold and in due course the sponge splits along it. The lobe then drops away and falls to the bottom. The split on the parent body heals as does the split on the fragmented piece, which, at the same time, grows a stalk that becomes fastened to a rock surface. Another method, where the vascles grow on the margins, is for these to drop off, the broken surface heals and each vascle grows a new stalk. There are 8 or 9 different ways in which a *purse sponge* can throw off bits of itself, each fragment then growing into a new *purse sponge*. The most extraordinary is that in which a line of holes appears across the equator of a *purse sponge*. The holes then rim into one another so that the outer half of the sponge is severed from the stalked half, rather like tearing two postage stamps apart. The two parts then heal, then wounds, the half that is still hanging from the rock growing a new mouth at the same time, while the other half heals the cut surface and grows a new stalk.



phylum	Parazoa
class	Gelatinosa
order	Calcarea
family	Syphidae
genus	
& species	<i>Siphaea compressa</i>

△ Section through simplest type of *Purse sponge* in organisation. The *purse sponge* is a complex animal with many internal structures. Left high but not dry a cluster of *purse sponges* attached to red alga *Pulmaria elegans*.

Puss moth

The puss moth is a member of the family

with fluffy hairs recalling the hair of a cat. The family is named after the prominent tuft of scales on the rear margin of the hindwings. The wings and body are whitish, the thorax is marked with dark spots and the abdomen with broad transverse bands. The wings have yellowish veins with black branches and the forewings have patterns of wavy lines. Puss moths are about 1½ in. from head to the tip of abdomen, the females being larger and with darker hindwings. Puss moths are found in most of Europe, across Asia to Japan and in North Africa.

Closely related to the puss moth are the kitten moths, smaller than the puss moth with darker bodies and more heavily patterned forewings.

Inconspicuous cocoon

Like all prominent moths, the puss moth is a night flier, whose results are not easy to ignore and can be found in May and June, in places where poplars, willows and willow groves. The caterpillars are found on the leaves of these trees. They are found sitting in pairs on the upper surfaces of the leaves where they hatch in June.

When small the caterpillars are black with a row of four white dots down each side. As they grow they develop a pattern of green and brown and when full grown the caterpillars are 2½ in. long.

The caterpillars have a very peculiar habit of making a small hole in the bark of a tree and then crawling into it. This is a very common habit of the caterpillars and is a very useful one.



long. While feeding the body appears hunch-backed, rising to a sharp peak just above the legs. Four pairs of prolegs support the rear part of the body and from either side of the tip of the abdomen rise the two long tails, broad near the base, with whip-like tips. Along the head and back runs a broad band of purplish brown edged with white which forms a saddle in the middle of the body. This pattern is an example of disruptive coloration, breaking up the outline of the caterpillar so that it is difficult to see among the leaves and is easily mistaken for a withered leaf.

The caterpillars feed throughout July and August, and sometimes into September. Then they select crevices in the bark of the trunk or branches of the tree in which they begin to feed. As the caterpillar weaves its cocoon of silk it incorporates small scraps of bark and chewed wood into the matrix, making the cocoon hardly distinguishable from its background.

Cutting its way out

The cocoon is a tough structure and the caterpillar leaves the skin at the head end thinner than the rest so that the adult moth can escape the following summer. To assist its escape once the moth has two means for opening the cocoon, one mechanical, one chemical. When it bursts out of the pupal case or chrysalis within the cocoon, a small part of the case remains attached by hooks to the moth's head. This bears two sharply pointed spikes which are used to cut a hole in the cocoon. After the moth has climbed through the hole it pushes this cutting tool off its head with its legs. Cutting is made easy by the secretion of a weak solution of caustic soda from the mouth which softens the tough wall of silk.

The caterpillar has a very peculiar habit of making a small hole in the bark of a tree and then crawling into it. This is a very common habit of the caterpillars and is a very useful one.



Red for danger

The bizarre caterpillar of the puss moth is remarkable for having two kinds of protective coloration. As already described the pattern of brown and green disrupts the outline of the caterpillar making it difficult to find. This is a passive form of protection, and does not help if the caterpillar is found by accident. Once disturbed, however, it rears up presenting a terrifying picture; the head is drawn in and the 'shoulders' hunched displaying a bright scarlet ring, with two black spots above it. This looks very much like a face and its sudden appearance probably scares enemies.

The scarlet ring is a warning. If further molested a burning 40% formic acid solution is squirted from thoracic glands.

Other moths of the prominent family possess similar means of defence. Many have protective coloration and one species secretes strong hydrochloric acid when disturbed. Stranger in appearance than the puss moth caterpillar is that of the lobster moth. This is found on beech, hazel, oak and birch from Britain to Japan. The caterpillar is brown, has two pairs of very long legs and the tip of the abdomen is raised vertically. When annoyed, the lobster caterpillar rears up and waves its long legs, looking like a large irate spider.

phylum	Arthropoda
class	Insecta
order	Lepidoptera
family	Notodontidae
genera	<i>Cerura vinula</i> puss moth
& species	<i>Harpyia kitten</i> moths
	<i>Stauropus fagi</i> lobster moth

▷ 'Shoulders' hunched, and a terrifying 'face' appears, the caterpillar of the puss moth in its defence posture (also overleaf).







Pyrosoma

Pyrosoma or "firebody", a free-swimming colony of sea-squirts, glows with a white light like that from molten iron. A colony of sea-squirts is like a cylinder tapering slightly to a narrow end which is closed. Each colony is 4 m. to several feet long and up to 10 in. diameter, and the surface is covered with tapering processes, one for each individual in the colony. The wall of the cylinder is made of a stiff jelly, almost like gristle, and embedded in this are the individual sea-squirts, numbering several thousand in the largest cylinders.

Sea-squirts, or tunicates, are a group of marine animals of relatively simple structure that seem to be related to the earliest vertebrates. They, with others such as the acorn worm (p. 9) and the lancelet (p. 1278) have been described as the pioneers of the vertebrates. Each sea-squirt is enclosed in a tunic of a tough jelly-like substance. It has a mouth through which water is drawn in, and a vent through which it is expelled. On its passage the water passes through a cavity, the walls of which form a fine-meshed network that acts as gills. Oxygen is taken from the water by the gills and minute particles of food are trapped by them and passed to the stomach. This will be described more fully under sea-squirt, only a brief description being given here, sufficient to understand how *Pyrosoma* is built and how it works. There is a continuous cylinder of jelly in which all the individuals making up the colony are embedded.

Simple jet propulsion

The feeding plan is, in essence, the same. Each individual sea-squirt draws in a constant stream of water which is expelled into the general current of the ocean. This combined

effluent can only find its way out through the opening at the broad end of the cylinder, which acts as a simple jet-exhaust, driving the cylinder through the water. The cylinders move slowly, only slightly faster than the speed of the current on which they are drifting. Each individual animal draws in water through its mouth, extracting the food particles from it, like an animated vacuum cleaner. *Pyrosoma*, which lives well out in the oceans of the tropics, swim well below the surface by day but at night comes up to the surface. Each individual has two light organs which flash when the colony is disturbed or touched. A ship passing through a shoal of *pyrosoma* at night leaves behind it a broad path of light where the propellers and the disturbed water from the wake has stimulated the *pyrosoma* to light up.

All the basket in one egg

There is no larva. The ovary contains only one ovum heavily charged with food-volk. When fertilised this divides repeatedly to form a multicellular embryo. From this a creeping stalk, or stolon, grows out and this becomes constricted into four parts. Each of these is the beginning of a new *pyrosoma*. They become surrounded by a jelly like tunic and the whole of this, the four young *pyrosomas*, and the original embryo from which they sprang, with its store of food-volk, leaves the parent and by continued budding from the four individuals, builds up a new colony.

Resident predator

The main enemy of *pyrosoma* is a planktonic ctenophore, *Physona* which looks like a caricature of a shrimp, with a large flattened head. It eats all the living parts of a *pyrosoma* colony, leaving only the cylinder of jelly—a real case of board and lodging since the shrimp lives inside the cylinder while becoming its lair occupants. Furthermore, the female *Physona* lays her eggs in the jelly barrel and can sometimes be seen inside surrounded by her brood.

Why lit up?

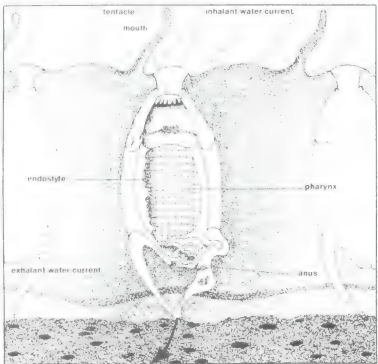
It would not be right if this strange and unfamiliar animal living on the high seas did not have its mystery. Its mystery is one it shares with a number of other animals and also some plants: the production of light by an organism that has no eyes. One of the first people to see a *pyrosoma* taken from the sea for study purposes was a naturalist on board HMS *Challenger* in 1873. HN Moseley. In the journal of the *Challenger*, Sir Wyville Thompson recorded that the ship, on its way from Madeira to Brazil, passed through an enormous shoal of *pyrosoma*. 'The wake of the ship was an avenue of intense brightness. It was easy to read the smallest print sitting at the after-part in my cabin; and the bows shed on either side rapidly widening wedges of radiance, so vivid as to throw the sails and rigging into distinct lights and shadows.' HN Moseley wrote his name with his finger 'on the surface of the giant *pyrosoma* as it lay on deck in a tub at night, and my name came out in a few seconds in letters of fire'.

Captain Brett Hilder, a ship's captain particularly interested in trying to solve the mystery of oceanic luminescence, noted in 1955 that the switching on of the ship's radar will make the sea momentarily glow with organisms such as *pyrosoma*.

But what possible purpose can this serve?

phylum	Chordata
sub-phylum	Urochordata
class	Thaliacea
order	Pyrosomida
family	Pyrosomidae
genus	<i>Pyrosoma</i>

◁ ▽ *Pyrosoma elegans* in the plankton with arrow worms, copepods and mysid shrimps.
▽ *Pyrosoma* (small, vertical section) lit.





Python

Pythons are the Old World equivalent of the New World boas. Like the boas they have small spurs that represent the vestiges of hind limbs. The largest and best-known pythons belong to the genus Python. Not only are these large pythons at home in jungles, climbing trees, but they are often found near water. The African rock python which reaches about 32 ft long is not quite as long as the accepted record figure for the anaconda, the largest of the boas (p 250). It lives in most parts of Africa in open country except the deserts. The other African pythons are the ball python and Angolan python of West Africa. There are no pythons in southwest Asia but several species are found from India to China and the East Indies. The Indian python reaches about 20 ft and ranges through southeast Asia from India to China and on some of the islands of the East Indies. The reticulated python,

reaching a length of 33 ft, has a more easterly distribution, from Burma to the Philippine Islands and Timor. The short-tailed python lives in the Malayan Peninsula, Borneo and Sumatra and the Timor python lives on the islands of Timor and Flores in Indonesia.

As well as the true pythons there are several other genera of pythons, including the carpet snake, that are found in the East Indies and Australia. Of the rock pythons the largest is the 20ft amethystine rock python or scrub python. A smaller group is the Australian *womans* which eat other snakes. The green tree python of New Guinea hunts in trees. The burrowing python, living in West Africa, in Liberia and throughout the Congo rain forest, spends its time underground chasing rodents and shrews.

Good travellers

The large pythons are often found near water and the Indian python is almost semi-aquatic. They also live in jungles and

△ A green tree python wraps its powerful body round a branch for some absorbing prey which it gapes without disgorging from its mouth. Its long greenish-yellow with white spots along its back and its extremely, powerful and snake-trail-like head is adapted for life in the trees.

climberies except for the African python which prefers open country. A tree-dwelling python shows a preference for living near human settlements. At one time it was a regular inhabitant of Bagdad, where kept by city and country folk. One specimen was caught in the Bagdad Palace. The habit of associating with humans has been noted for its nearest relatives, the *hippitypes*. One reached Florence in 1860. Hippitypes are regarded with some suspicion in some of the regions where they live. In Karamoja in the East, an epidemic after a crop failed in 1888, destroying all life.

Any five just as good

Pythons kill but pose no serious threat to people themselves around the world. The



© J. Simon. Photo: AP/Wide World

prey, striding it caput in cauda. The coils then hold the body steady while the python works it into its mouth. Prey is caught by ambush; the python lies in wait, then springs out knocking the animal with its head and seizing it with its jaws until it can wrap its body around it. The list of animals eaten by pythons is too long to summarize. Mammals are preferred, followed by birds, but some rock pythons have been caught in fish traps. African pythons eat many small antelopes, such as dikers, gazelle, impala and bushbuck. A large python can swallow prey weighing up to 120 lb, but this is exceptional and usually smaller animals are taken, such as civets, hares, rats, porcupines and chicks. Jackals and monkeys are sometimes eaten and one 18-ft African python is known to have eaten a leopard with some little damage being sustained in the process of catching it. Pythons sometimes suffer from their meals. They have been found with porcupine quills and antelope horns sticking through their stomach wall. Usually such dangerous projections are digested before causing any serious damage.

A large animal will last a python for a long

time but they sometimes kill several small animals in quick succession. An African python has been credited with capturing and eating three jackals and a small python was seen to kill two sparrows in quick succession, then pin down a third with its tail.

There are a few authentic accounts of men being attacked by pythons, and there is good reason to believe the case of the 14 year old Malay boy attacked and eaten on the island of Salehabu.

Devoted mother pythons

The courtship of pythons is less lively than that of smaller snakes. The male crawls after the female, trying to climb over her and sometimes they rear up and sway to and fro. The spurs or vestigial limbs that lie either side of the cloaca are used by the male to scratch the female and stimulate her to raise her body so that he can wrap his body around hers and bring the two cloacas together. The eggs, 100 in a single clutch, are laid 3-4 months after mating. The female gathers the eggs into a pile and wraps herself around them, brooding them throughout the 2-3 month incubation

period, only leaving them for occasional visits to water and more rarely to eat. Most pythons merely guard their eggs but the Indian python incubates them by keeping her body a few degrees above that of the surrounding air. Reticulated pythons are 2-2½ ft long when they hatch and for the first few years they grow rapidly at a rate of about 2 ft or more a year. An Indian python nearly trebled its length in its first year of life. Pythons may live for over 20 years.

Courageous otters

Even the great snakes are not free from enemies. Young pythons have many enemies but as they grow larger fewer animals can overcome them. Crocodiles, hyenas and tigers have been found with the remains of pythons in their stomachs and Jim Corbett writes of finding a 17ft Indian python killed by a pair of otters which had apparently attacked from either side, avoiding harm by their agility. When the ball python of Africa is molested it rolls itself into a tight, almost uniformly round ball, its head tucked well inside.



Beating elephants

Both African and Indian pythons were well known to the Greeks and Romans and have taken their place in folklore and religion. They are, for instance, responsible for one of the many dragon legends. Dragon is derived from the Greek word for snake, and the ancient writers were obviously talking about big snakes. It was mediaeval naturalists who turned them into fabulous creatures. Edward Topsell has left us a delightful description of how dragons capture elephants. In his *Historie of Serpentes* 1608 he writes how they 'hide themselves in trees covering their head and letting the other part hang down like a rope. In those trees they watch until the Elephant comes to eat and cropp off the branches, then suddenly, before he be aware, they leape into his face and digge out his eyes, and with their tayles or hinder partes, beate and vexe the Elephant, untill they have made him breathlesse, for they strangle him with theyr foreparts, as they beat him with the hinder.' Apart from the impracticability of an elephant being attacked, this is a reasonable account of a python killing its prey.

◊ 'Strangled' A flying fox, caught in the jaws of a scrub python, is being strangled to death by the python's tightening coils.

△ A carpet python *Morelia spilotes* curls over and around her eggs, rarely leaving them. The temperature within her coils is up to 121 degrees warmer than the surrounding atmosphere.

▷▷ A ball python emerges from its egg, after an incubation period of up to 80 days. It may be one of a hundred snakes in the clutch.

▷ Superfluous legs. The two claws (arrows) on either side of the anal vent of this African python are vestigial hind limbs, reminding us that snakes evolved from legged reptiles.

▽ The African python's skull shows the typical arrangement of teeth of a non-poisonous snake. The even sized teeth all point backwards, which ensures a firm and fatal grip on their prey.



class	Reptilia
order	Squamata
suborder	Serpentes
family	Pythonidae
genera & species	<i>Calabaria reinhardti</i> burrowing python <i>Chondropython viridis</i> green tree python <i>Liasis amethystinus</i> amethystine rock python <i>Morelia argus</i> carpet snake <i>Python anchietae</i> Angolan python <i>P. curtus</i> short-tailed python <i>P. molurus</i> Indian python <i>P. regius</i> ball python <i>P. reticulatus</i> reticulated python <i>P. sebae</i> African python <i>P. timorensis</i> Timor python



Quail

There are nearly 100 species of quails in the world. Those of the Old World are represented by the migratory quail. Those of the New World include the bobwhite and the crested quails. The two groups, although resembling each other superficially, and being similar in habits, are markedly different in their anatomy.

The name quail came into common use between 1550–1620 and is best known as the name of the birds that succoured the Children of Israel. It was doubtless taken to North America at that time. Then the name largely went out of use but was revived again in the mid-18th century.

The migratory quail, the quail of the Bible and the one common across Europe, Asia and North Africa, is small, plump, 7 in. long, with a very small tail and a weak beak and legs. The plumage is buff and brown mottled, barred and streaked with black, dark brown and white. Related quails of similar build, living in Africa, southeast Asia, Australia and New Zealand, are more brightly coloured.

The New World quails are usually slightly larger than the Old World quails and more brightly coloured. The tail may be short or moderately long and the bill is stronger, with sharp and more or less

in addition to having crests of various shapes and lengths, are the most colourful of all.

Slow off the ground

Quail are like partridges in habits (p 1709); if anything, they are more reluctant to fly. Like partridges, they keep to arable land or pasture, and avoid tall vegetation. When flushed they fly low, 3–4 ft from the ground for short distances. They form small family

parties or bevs and even on migration are in parties of no more than 40 or so. The male's call has been popularly rendered as wet-my-lips. The female's call is a double note, *brub-brub*. The migratory quail were formerly found in tremendous numbers, and in the Middle East were knocked down with sticks. In mediaeval times large numbers reached northern Europe during the summer. In England, in 1466, a 100 dozen quails were served at a banquet given to the Archbishop of York. Even up to the 18th century there were many reports indicating an abundance of quails in England. The New World quails have similar habits but none is migratory. The bobwhite, a name based on the call of the male, is a popular gamebird. The marbled wood quail of Barro Colorado is remarkable for its duets: male and female stand facing each other a foot apart, calling *corcorovado*; he calls *corcoro*, and she adds the *vado*.

Their food is for the most part of other members of the pheasant family: seeds, grain, insects, small snails and other small invertebrates are eaten.

Perfunctory courtship

In the breeding season the male migratory quail takes up a territory from which he drives out other males. A female arrives, chooses a nesting site and then calls to him, the two indulging in duets. The male goes over to her and circles her, dragging his wings, stretching out his neck and puffing out his throat. After mating the female makes a shallow scrape in the ground, lines it with a few bits of grass and lays her 7–12 eggs, yellow-white with amber to chocolate markings. The hen incubates for about 3 weeks. The young leave the nest within a few hours of hatching, and can fly well at about 19 days. The breeding details for bobwhite and related New World quails are similar, with the males taking a greater share in tending the young. Bobwhites lay a larger clutch on average, with 12–18 eggs. The crested quails have a slightly more elab-

orate courtship in which the male, more colourful than the female, ceremoniously presents his mate with food. Between the offerings he bobs up and down, whistles low and dances around her with mincing steps, before mating takes place.

Explosions of quails

Like partridge coveys, the bevs of quails roost in circles with their heads turned outwards. Bobwhites use the circle as a defensive formation, 'exploding' in such a way as to confuse a predator. Even so, because they feed, sleep and nest on the ground all quails are vulnerable to ground predators such as foxes and snakes, and they are also attacked by hawks and owls.

Arriving together

A bobwhite hen lays one egg a day until 4 or 5 are laid, then she may miss 2 or 3 days before laying the next. So a clutch of 18 may take over three weeks to lay. Yet, at the end of the 23–24 days' normal incubation period, all the eggs hatch within an hour or two. It is the same with partridge, pheasant and red grouse. To some extent this is because the hen does not start incubating until the full clutch is laid. Nevertheless, if the eggs are then taken from her and put into incubators separately, the first laid hatches first and there is a fair time interval before the last one hatches. Experimental work, done largely by Margaret A Vince at Cambridge University a few years ago, has an interesting sequel. Two days or so before the eggs hatch they are pipped, that is the chick pecks a tiny hole and starts breathing by its lungs. A day later the chick starts to flick. That is it makes sounds regularly 80–150 per minute which can be heard when the egg is held to the ear. When the eggs in a clutch are separated even by a few inches they do not hatch together. Synchronised hatching only takes place when they are close together or almost touching. It seemed that the most advanced





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eggs were causing the less advanced to speed up their development and that the less advanced were, at the same time, holding back the more advanced, making them mark time. Further tests showed that chicks nearing the hatching time can be stimulated to develop more quickly, when subjected to vibrations of the same frequency as the chickings. What makes the more advanced ones mark time is less clear.

class	Aves
order	Galliformes
family	Phasianidae
genera & species	<i>Coturnix coturnix</i> migratory quail <i>Colinus virginianus hoholite</i> <i>Odontophorus gujanensis</i> marbled wood quail, others

△ A female migratory quail on her nest, has a cast from the male. The hen chooses the nesting site and then calls to attract a male. After a brief courtship they mate and she then leaves the nest and begins to rear the family. ▽ A small party of valley quails, *Lophortyx californicus*, scratch around on the ground for seeds, grains, insects and other food. Most American quails are brightly coloured and they have longer tails than the Old World quails.





T. K. K. K.



K. K. K. K.

Quelea

The quelea is such an important agricultural pest, doing millions of pounds worth of damage to crops in Africa every year, that its generic name *Quelea* has become accepted in the English language. There are, however, three species of the genus *Quelea* and they do have a common English name, being known as doves. The quelea's full name, red-billed quelea, draws attention to the feature which best distinguishes it from the other two species. It is a small bird, rather like a sparrow, but with a stout, conical red beak. In breeding dress the male has a buff head and breast and a conspicuous mask on its cheeks. The mask is usually black, but in a number of males it is buff and barely noticeable. This is an example of dimorphism (see guillemot, p 978), with the black-faced form making up 80–90% of the population. After the breeding season the male moults his brighter coloured feathers and becomes brown and 'sparrowy' for several months. The female is always dull, like the male in non-breeding dress. Only her bill changes colour: from red to bright yellow at the height of the breeding season.

The quelea is found throughout the dry savannahs and grasslands of Africa south of the Sahara, a total range of over 2 million square miles.

Vast flocks

At times, queleas can be seen in quite incredible numbers on the rich flood-plains throughout the semi-arid regions of Africa. At other times, one can travel hundreds of miles across the same plains without seeing one. A single quelea is an unusual sight as they usually move about in tight flocks of hundreds to tens of thousands of birds. During the early morning, the birds feed intensively in dense clusters that form living carpets often a hundred square yards or more in area. They quickly fill their stomachs and crops and when the crop is full it bulges out like a balloon so the contents can be readily identified through the stretched skin of the neck. During the hot hours of the day, the flocks gather in some shady place, usually near water. There they sit chattering and preening, and from time to time fly down in groups, to drink on the edge of a pool. In the cool of the late afternoon, there is another feeding session. At dusk the flocks fly to the communal roost—a patch of thorn-trees, or a reed-bed, to spend the night. The roost can be colossal, with many millions of queleas packed into a few acres. Along the Nile, in the Sudan, where some of the biggest roosts occur, tree branches as thick as a man's thigh are often broken by the combined weight of thousands of queleas sitting on them.

In their daily activities, the flocks may move 30–40 miles from the roost, but sometimes queleas fly much greater distances. Birds ringed in South Africa have been re-

covered a thousand miles away in Malawi. Whether the birds are truly migratory, or just move in search of food is not known.

Spreading the loss

The natural food of queleas is the dry seeds of wild grasses. During the rainy season the seeds are stripped from the growing grasses, but in the longer dry season they are picked up off the ground. Unfortunately, quelea treats cultivated grasses, the cereal crops, just as it does the wild ones. Enormous numbers of queleas assemble in crop-growing areas when the rice, wheat, or guinea-corn is ripening. By constantly feeding on these crops prior to the harvest, they can take a great deal of the grain, and sometimes completely strip the fields. Peasant farmers crack whips, bang drums, and shout for all they are worth to deter the birds. All they can do is to make sure the damage is shared equally by all, as the queleas merely fly to the next field. They still return to the roost every night with their crops bulging with grain.

Large rice- and wheat-growing schemes are now being developed all over Africa. These crops mature later than wild grasses, so providing plenty at a time when queleas were once forced to travel in search of food. As much as 10–20% losses of crops are not uncommon, and in some places, a quarter of the crop has disappeared down the birds' gullets before it can be harvested.

Closely packed families

Queleas probably breed only once a year. At the beginning of the rains, which come at different times in different parts of Africa, the birds come into breeding condition. At the height of the rains they assemble in suitable breeding places. Often a line of acacia trees on the edge of a large swamp is selected, or they may choose to build in the swamp itself. The nests are packed very close together, and trees only 30 ft tall may carry several hundred nests, while a single large colony, sometimes covering several miles, can hold millions of nests.

The males begin the building, and attract a female by displaying on the half-finished nest. After mating, the nest is quickly completed by the two partners. It is woven from strips of green grass and is a roughly oval structure with an entrance hole on one side. The eggs, usually 3, are often laid even before the nest is finished, and hatch in 10–12 days. The nestlings are fed on caterpillars, grasshoppers and other insects for a few days and grow very rapidly; then they are given grass seeds. After about 2 weeks, the young leave the nests, finally flying away when about 1 weeks old.

Few enemies

One might expect the swarms of queleas to attract large numbers of predators, but this is not so. Falcons and goshawks can often be seen harrying the flocks, but when threatened, the queleas bunch together in close formation, and the dense mass of birds quickly twists and turns. All the hawks can do, it seems, is to catch the odd sick or injured bird that gets left behind. Men take queleas for food, and many drown when flocks drink at shrinking water holes.



▲ A havoc of destruction surrounds a tree in the African savanna. Queleas cause widespread damage by feeding on grasses and cereal crops.

◀ The male red-billed quelea takes the initiative. He begins the nest and then looks for a female to help him complete it.

△ A red-billed quelea, slightly seen at first with its side entrance, is ready for occupation.

Is there no end to them?

For over 20 years, control units have been killing queleas all over Africa. The present toll is well over 1000 million a year. Yet there are apparently still as many queleas around as ever. Although vast numbers of birds are destroyed, the proportion of the total population killed is quite small, and can be replaced even by their relatively slow rate of reproduction. If nests or young queleas are destroyed the adults start to breed again almost immediately. Many of the breeding places are completely inaccessible to the control units and many others still remain to be discovered.

Queleas are killed wherever they concentrate. At night roosts are sprayed from the air with deadly poisons or are blasted with explosives. The breeding colonies are sprayed or flameschroovers roast the young before they learn to fly. However horrible these tactics seem, they must go on, at least until some better method of protecting Africa's much needed grain can be found. Even the blowing up of colonies at night after the adults have returned to roost has limited success, because numbers are so enormous. The tactics of queleas to the food supply of Africa can only be ended after extended research into their habits. This is harder work, but success is not likely to come easily.

Class	Aves
Order	Passeriformes
Family	Plocidae
Genus	<i>Quelea cardinalis</i>
& species	<i>Q. erythrops</i> red-headed quelea <i>Q. quelea</i> red-billed quelea

Quetzal

Also known as the resplendent trogon, the quetzal ranks as one of the most beautiful birds. It measures 14 in. from bill to tip of tail, but, like the peacock, the tail coverts are extremely long, trailing behind the quetzal as shimmering plumes up to 2 ft in length. The head, which bears a tufted crest, the neck, chest and wing coverts are iridescent golden green. The wing covert feathers are plume-like, overhanging the crimson lower breast and belly. The back shimmers with blue and green and the long tail coverts are iridescent green. The female is duller, lacks a crest and the tail coverts are

Quetzals are found in the forests of Central America, from southern Mexico to Panama, but are now becoming increasingly rare.

Mind my tail!

The forests of the Central American highlands are extremely humid, bathed continuously in rain and mist. This high humidity favours the growth of epiphytic plants which grow in great profusion on the trunks of the tall trees that form a canopy over 100 ft high. The quetzals live among this rich profusion of plants, feeding on the leaves and berries, which they pluck while in flight in an action reminiscent of flycatchers. Flying from its perch, a quetzal takes a berry in its bill, tears it off and regurgitates one part. The male quetzal has an unusual habit of launching itself backwards from its perch. If it flew straight from its perch in the normal manner the long feathers on its train would be torn to shreds in no time. The female does not appear to take this precaution.

Quetzals usually stay in the dense forests and sometimes come out to feed in clearings. In the forest, the quetzals give away their position by their habit of rapidly fanning their tails to show flashes of white. They also call loudly in flight, and during the breeding season the males have a variety of deep, powerful calls and songs that match their beautiful plumage. The males also have a display flight, circling above the forest canopy and calling loudly.

Inaccessible nests

Quetzals nest in holes in tree trunks, either enlarging existing woodpecker holes or excavating their own. Their bills are short and blunt, suited for eating soft fruit rather than chiselling wood and so quetzals can make their holes in only the most decayed trees. Both male and female take part in nest building, biting and tearing strips of soft wood until they have made a hole with an entrance about 1 in. across and up to about 1 ft deep.

The clutch of two light blue eggs is laid on the unlined floor of the hole and incubated by both parents in turn. According to Guatemalan folklore the quetzal's nest has two entrances, so that the male may sit on the eggs without ruining his train. He is supposed to enter through one side,



△ Not just a pretty bird. The quetzal is the Guatemalan symbol of currency. >Deceptively feisty. The long tail feathers are hidden under the long iridescent green tail coverts which may be up to 2 ft in length. The wing coverts form shimmering golden green plumes which overhang the crimson lower breast and belly.

incubate with his train hanging out, then depart through the other side. In Costa Rica the quetzal is supposed to have found a different remedy. He is said to sit on the eggs with his head facing inwards and his train trailing out through the single entrance. Few people have seen quetzal nests because of the inaccessibility of the forests and the difficulty of locating nest holes in trees covered with a rich growth of epiphytic plants. Presumably the problem of how the quetzal protected his train occurred to some people and these were the solutions they proposed. In fact, the train is sufficiently hardy to dispense with such elaborate behaviour. We now know that the male quetzal incubates facing the nest hole with the tail pressed vertically against the back wall. The train curves over his back and projects some inches through the entrance.

The eggs hatch after 17–18 days incubation. The chicks are naked and blind at first and for the first few days are brooded by their parents, who also keep the nest clean by removing the eggshells and droppings. The chicks are fed on insects and other small animals until they are nearly 2 weeks old. Then fruits, especially those of the laurel family, are brought by the parents and later snails, small frogs and lizards. The nestlings fly when about a month old.

The feathered serpent

Considering the beauty of the quetzal it is not surprising to find that it is the national bird of Guatemala. It is not only figured on postage stamps but also on the national flag, and the Guatemalan unit of currency is the *quetzal*. A pretty story has it that a captive quetzal soon dies of a broken heart. Such reverence for the quetzal has not saved it from the feather trade. After its discovery by Europeans it soon became so rare that some people declared it was a mythical bird, but in the 19th century it was rediscovered, and only the inaccessibility of its home in the forests saved it from extinction.



Allen Photo

Before the Spanish Conquest the Aztecs of Mexico had also held the quetzal in high esteem and their mythology contained a 'feathered serpent'—*quetzalcoatl*. Quetzal feathers could only be worn by nobles and the long plumes were plucked from live quetzals who were then freed to grow new feathers—and sire more quetzals.

class	Aves
order	Trogoniformes
family	Trogonidae
genus & species	<i>Pharomachrus mocino</i>



Quokka

The quokka is a wallaby that is hardly as big as a hare and looks like a large rat. Another name for it is short-tailed pademelon wallaby; the Aborigines call it quak-a. Head and body together measure only 2 ft and the adults weigh up to 11 lb. Its short, 14-in. tail is twice the length of its head; its hindfeet are only 4 in. long. The short coarse fur is brownish grey with a reddish tinge around the head and chest. Its ears are short and rounded, almost hidden in the fur.

The quokka lives in swamps and brush in southwest Australia, especially on Rottnest Island. It was on this island in 1658 that a Dutchman, Samuel Vlakersen, first saw the quokka which he described as 'a wild cat resembling a civet cat but with browner hair'. In 1696 another Dutchman, Vlaming, took the quokkas to be giant rats when he first visited the island, so naming it Rottnest (= Rat's nest) Island. Not until 1830, when a dead one was found and examined by the French zoologists Quoy and Gaimard, was the quokka found to be neither a rat nor a wild cat but a wallaby.

Sheep-like quokkas

Quokkas live where there is dense grass, a moderate amount of scrub and scattered trees, making runways and tunnels through the vegetation. Although their hindlegs are proportionately shorter than those of a rabbit, they hop like kangaroos when going fast. When moving slowly they do not use the tail as a prop like other wallabies.

△ *Shady retreats:* Quokkas like the shade of a keep cool but conserve their energy by avoiding the direct heat of the sun.

They feed mainly at night, resting in the shade during the heat of the day. They feed on various kinds of grasses and herbaceous plants, and during dry summers they seek out succulent plants to make up their water content as well as damp places where water oozes from the ground.

Like rabbits, they crop the vegetation and prevent regeneration of trees by eating the seedlings, but they resemble sheep in their digestion. They are semi-ruminants, possessing several kinds of bacteria in their stomachs which break down tough fibres.

Baby in reserve

Mating takes place only in winter. The period of gestation is 27 days and the single newborn joey weighs ½ oz. It leaves the pouch at the age of 6 months but runs still go back into it for shelter and rest until it becomes fully independent at 10 months. Quokkas mature at 2 years.

Quokkas are one of the species which have delayed births. Should the joey that is already in the pouch and attached to a nipple be removed or die, another joey will be born without further mating by the mother. The answer to this is that a female quokka can become pregnant soon after the joey is born. The fertilised egg divides repeatedly until a hundred cells are formed, arranged in a tiny ball-like sphere, known as the blastocyst. So long as one joey is suckling another, nothing happens. The blastocyst lies quiescent in the uterus. Should the first joey die, the blastocyst begins, 2 days later, to develop further, and 27 days after that, another joey is born. This kind of delayed birth has been noted in several species of marsupials.

Mystery of crash deaths

The abrupt deaths seem to have killed quokkas in large numbers by setting fire to the bush and sparing them as they ran out to escape the flames. Yet in the early days of the settlement of Australia quokkas were still plentiful and their numbers were not seriously reduced until 1921 when there was a very high bush rate and the same occurred in 1933. The causes, however, and it could not have been due to introduced rabbits, since quokkas were not foxed, preyed on there. Rabbits and foxes had not reached the island by 1921, although both had arrived by 1933. After the 1921 crash the populations of quokkas readily built up again. This did not happen after the 1933 crash because rabbits had over much of the grasslands and foxes were there in sufficient strength to prey on the quokkas. Today the quokkas are most numerous in the reserve set aside for them on Rottnest Island, where they numbered around 10,000 a few years ago. On the mainland they are now rare.

Starving by not drinking

The quokka leads a precarious life, partly because of its need for water, and partly because of its being a semi-ruminant. It keeps cool in hot weather by licking its forelegs and its chest, the evaporation of this water lowering its body temperature. Unless it can find plenty of water, too many mineral ions are lost in the saliva. These ions are needed to maintain so much acidity necessary for the bacteria which break down the fibres taken in as food. A quokka needs only 1 oz of protein a day to keep its diet balanced. It can get this from the fermentation of plant fibres in its stomach and by digesting the bacteria. It can also retain nutritious waste instead of excreting it, and this passes into the stomach where the bacteria convert it to fresh protein, during which time the bacteria themselves grow and increase in numbers.

Inside the quokka body, therefore, is a remarkable means of making do on meagre supplies. It all depends, however, on the quokka not getting too thirsty, which in turn depends on its not having to lick itself too much. Shade is essential for keeping its body temperature and too many quokkas in one area means the seedlings do not grow into bushes or trees to provide shade. This may be one of the causes of the crash in population in 1921 and 1933. It is certainly a problem that needs to be solved on Rottnest Island, where 10,000 quokkas live in 1,400 acres. Since this is a conservation area protected but a number of the high dilly could starve after the next dry season, to look themselves in the mouth.

class	Mammalia
order	Marsupialia
suborder	Allotheriidae
genus	
species	<i>Setonix barchinensis</i>





Photo: J. C. G. G.

Rabbit

The European rabbit was originally a native of southwest Europe and north-west Africa, but has spread northwards largely with human help. First the Romans, then the Normans were blamed for introducing the rabbit to Britain. Now there is evidence that it was not in Britain until the 12th century and was then regarded as a desirable domesticated animal, farmed in warrens and zealously guarded. It used to be classed as a rodent but is now placed in the order *Lagomorphi* along with hares and pikas (see hare, p 1019). It has long ears and large prominent eyes placed well to the sides of the head. The strong hindlegs are longer than the forelegs and provide the main force in running. Instead of having pads on the soles protecting the feet there is a thick coating of hair which gives a firm grip either on hard rock or slippery snow. The tail, which is white below, is very short and turned up at the end. The coat is a mixture of dusky and buff on the upper parts with grizzled white underparts. The fur is of triple formation: there is a dense, soft woolly underfur, through which project the longer and stronger hairs which give the coat its colour, and among these are still longer but more sparsely scattered hairs. The coat becomes thicker in winter. The bucks are slightly larger than the females and may be up to 16 in. long, and weigh up to 4½ lb. The females are distinguished by the form of the head which is longer and more delicately moulded than that of the male. Under a rabbit's chin are glands, larger in the buck than the doe, which produce

a secretion used for marking territory. Rabbits will also rub their chins on each other, especially on a mate or on the young, presumably to provide a ready means of recognition.

Rabbits have been extensively bred for food and as pets and for laboratory experiments. Black rabbits and, more rarely, other colour mutants, turn up occasionally in wild populations and these have been used to produce domesticated breeds some of which bear little resemblance to the original wild stock. There is, in fact, a wide range of colour, and the fur of some breeds is very long and silky. Those bred for their meat may reach a weight of 15 lb. The name 'rabbit' appears to be of northern French derivation, and originally included the suckling young, the adults being known as conies.

The rabbit has now been introduced into many other parts of the world including the Ukraine, the Azores, Madeira, Australia, New Zealand, South America and several parts of the United States. In some places where they have been introduced they have no natural enemies, and consequently have caused widespread devastation of the grasslands and robbed the native animals of their food, particularly in Australia.

Underground community

The rabbit lives mainly in grasslands or open woodlands where it digs extensive burrows. They are gregarious and live in burrows close together so the warrens may cover a wide area. Although so famous as a digger the rabbit is not specially built for burrowing, yet where the soil is light the combined efforts of many generations have resulted in extensive and compli-

ed 'tunnels all round'. Rabbits 'take round a corner hole in Australia. With no natural enemies here their numbers have increased to such an extent that widespread destruction of the grasslands has occurred.

At 4 young rabbit 'ventilators' shows its foot. It is brown black, deep and narrow, which has become independent after 30 days.

cated systems of burrows with hollows as emergency exits and stoppings for pursuers use. Although rabbits use the light sand of dunes, or a sandy heath overgrown with tuze and heather, they will also drive tunnels into a firm loam or dry clay. They have also been known to burrow deeply into a surface of coal. The forepaws are principally used to loosen the earth which is then kicked back with the hindfeet. If they meet stones that cannot be loosened by the paws, rabbits have been known to remove these with their teeth. Typical tunnels are about 6 in. in diameter, increased at points along their length to 1 ft to provide passing places. The living quarters are always thin chambers leading from the main passages. Adult rabbits use no bedding materials but rest on the bare soil. The rabbit is mainly nocturnal, coming out of its burrow in the evening and returning in the early morning.

Devastation of crops

Almost exclusively vegetarian, the rabbits' chief food is grass and the tender shoots of trees. In winter sheep fields are not available to them. If soil is light and before the disease myxomatosis was introduced as a means of limiting their numbers on the former Occasional a rabbit will not graze on earthworms. A rabbit eats two types of droppings: the first is a small, green, apple-shaped droppings, or 'droppings', which are eaten, and the other is a small, round, red droppings, which are eaten.

Prolific breeders

Rabbits are not promiscuous breeders as has long been thought but are polygamous, one buck mating with several does, each doe keeping to her own territory within the warren. Litters of rabbits succeed one another rapidly at intervals of about a month from January to June and there is some sporadic breeding in other months. Mating is preceded by a courtship in which the buck chases the doe. The gestation period is 28 days.

The pregnant doe makes a bed for her young, of hay and straw lined with fur stripped from her underparts. The nest is usually in the blind end of a 'stab' or 'stop', a short burrow about 2 ft long, just under the surface and well away from the main burrow. This is a necessary precaution against the young being killed by the buck. The doe visits the nest to suckle the young for about 3 minutes once in every 24 hours. The entrance to a stop is closed with earth after each visit, and some does will spread dried grass over this to hide it. The litters vary from two or three to eight, the higher numbers being those of the warmer months. The newly-born rabbits are blind, stout and almost naked. Their ears are closed and have no power of movement until about the 10th day, the eyes opening a day later. In a few more days the young rabbits can run and make short excursions from the nest. They start taking solid food at 16 days and are weaned after 30 days, when they are capable of an independent existence. Until then the mother will defend them from all dangers, including the weasel and the stoat, using her powerful hindlimbs against her adversaries. The weight at birth is 1–1½ oz which increases to 9½ oz in 3–6 weeks. Sexual maturity is reached in 3–4 months.

The number of young born does not correspond with the number of eggs fertilised. In recent years it has been established that a percentage of the embryos are resorbed, which means there is a degeneration of the embryonic tissues, the substance of which is taken back into the mother's body through the wall of the uterus. Sometimes whole litters are resorbed. Another piece of recent information is that 36 does, under close observation, reared 280 young, of which 252 disappeared during the season, presumably dying from natural causes.

Surface nesters

There have been reports in the British Isles and Australia of rabbits' nests, with young, on the surface. Surface nesting became pronounced soon after myxomatosis struck the rabbit, and one view put forward was that non-burrowing individuals may have been less prone to the disease and by their multiplication a population was produced with a high ratio of surface nesters.

Thumping on the ground

The rabbit's chief enemies, in addition to man, are the members of the raptorial family: cats, owls, buzzards, ravens, crows, black-backed gulls, and a variety of hawks. Badgers dig out the young and foxes also take a large toll, as do cats and dogs. When disturbed an alarm signal is made, usually by an old buck thumping the ground with



Jane Barlow. Photo: BHS

△ A rabbit finds a sunny secluded spot among viper's bugloss *Echium vulgare* on a cliff.
▷ A warm fluffy bundle of white angora and crumpled in the grass. There is a wide range of colour and fur among domesticated breeds.

both hindfeet together, to which all rabbits within earshot respond by dashing towards their burrows. A rabbit, terror-stricken by the imminent attack of a stoat, will utter a loud scream. Apart from this rabbits are normally silent, except for occasional low growls and grunts, although a doe has also been heard to utter low notes when nursing her young.

Results of myxomatosis

In 1954 and 1955 an introduced disease known as myxomatosis, made the wild rabbit a rare animal in western Europe. The disease has now become attenuated, and there are signs of the rabbit recovering, but usually, as soon as numbers begin to build up in any locality, the disease seems to take its toll once again.

The effects of rabbits' feeding on the countryside in the British Isles were highlighted by the changes following the first wave of myxomatosis. The first results noticed, following the drastic reduction in numbers of rabbits, was that in a year or two green lanes became choked with long grass, seedling trees and brambles, while the margins of cultivated fields were not being eaten bare. On downlands not being cropped by sheep the grass grew taller. At the same time many wild flowers became more plentiful, and wild orchids in particular became more abundant.

A report published in 1960 told what happened in the next stage. Unrestricted growth of the grass led to turf becoming less dense and as a result there was a deterioration in the wild flowers that had so suddenly burst into prominence as the



Royce Thompson

numbers of rabbits fell. There was an increase in brambles, gorse and heather. The most surprising feature of the report was the statement that the vegetation and scenery had reverted to its condition before 1840. It seems that until then there were relatively few rabbits outside the carefully guarded warrens where they had been preserved since the twelfth century in a state of semi-domestication.

class	Mammalia
order	Lagomorpha
family	Leporidae
genus	
& species	<i>Oryctolagus cuniculus</i>



Rabbitfish

The 30 or more species of rabbitfishes get their name from their rounded nose and their rabbit-like teeth. The name has also been used for the chimaera (p 427) and the burrfish or spiny boxfish, one of the porcupine fishes (p 1823). By common consent it is now reserved for a family of fishes remarkable among other things for the unusual markings on their bodies. These are usually described as reticulate, and this, strictly speaking, means a network with square-sided mesh. The markings on a rabbitfish may be spots or mottlings but more often they are made up of irregularly curving lines which, when closely set, look more like a maze pattern. This could be better described as scribbling and should be properly called vermiculate.

Rabbitfishes can grow up to 2 ft long, but are usually 1 ft or less. They have almost oval bodies, somewhat flattened from side to side, with a short tail. The dorsal fin runs the length of the back and its front three-quarters is supported by 13 stout spines, the first of which points horizontally forwards. The anal fin is long and its front two-thirds is supported by 7 stout spines. Each pelvic fin has 5 spines the outer two stout, the 3 between soft. Each stout spine is grooved and has a poison gland at its base. The spines can inflict a painful but not dangerous wound.

Rabbitfishes live inshore, ranging from The Red Sea to the coast of South Africa, across the Indian Ocean to the Pacific, southwards to the Great Barrier Reef and northwards to Japan. Some enter brackish water and two species live in freshwater.

Coral reef browsers

Rabbitfishes are noted for their rapid colour changes, which is a common feature of coral reef fishes, and they are mainly herbivorous, browsing the small seaweeds on corals and rock surfaces and biting off a certain amount of animal food at the same time, such as coral polyps. Rabbitfishes are sometimes eaten by man although they are not first class food fishes and certain species are known to cause food poisoning.

Artificial fertilisation

Rabbitfishes have never been seen spawning but in 1953 two Japanese zoologists, Shiro Fujita and Masaaki Ueno, took the eggs and milt from captured fishes, artificially fertilised the eggs and watched them develop. The eggs are colourless, $\frac{1}{16}$ in. diameter. They hatch in 27 hours, the larvae being $\frac{1}{16}$ in. long and without visible eyes, mouth or pectoral fins and so they cannot do much more than wriggle their bodies and feed on the contents of the yolk sacs. In 20 hours after hatching the pectoral fins start to grow, and in 48 hours the eyes are black, and the mouth open and the larval fish ready to feed itself.

New Suez crisis?

The Suez Canal has posed other problems than those concerned with international navigation. One of these, which has attracted attention for more than half a century, is whether marine animals would pass from the Mediterranean to the Red Sea and vice versa. The fauna in the eastern Mediterranean is remarkably poor compared with the western half of that sea, and it is also poorer than in the Red Sea. At the southern end of the 100 miles of the Canal the water is a foot higher than at the Mediterranean end and for nine months of the year the flow is from the Red Sea northwards, so there should be a mass

△ Like other rabbitfishes, *Siganus* are usually covered in a variety of irregular markings, and like most coral fish, can change colour rapidly.

migration of Red Sea species into the eastern Mediterranean. Yet in 1929 Walter Steinitz found that only 15 species, including shrimps, oysters and fishes, had gone north and nothing had migrated southwards.

One barrier was the Great Bitter Lake, through which the Canal passes. This had a layer of salt on its bed estimated at 1 000 million tons. This very salty area of water has been changing. The salt has been gradually dissolving out. At the same time the Aswan Dam has made a difference to the flow of fresh water down the Nile to the eastern Mediterranean. One result has been that the seas at either end of the Canal are becoming more alike, and so is the water passing through the Suez Canal. Even up to a few years ago only 16 species had got through from the Red Sea and only two had penetrated south from the Mediterranean. One of the 16 that got into the Mediterranean was a rabbitfish *Siganus rivulatus* that had got as far as Cyprus.

In 1967, Gunnar Thorson, a marine biologist at Elsinore, Denmark, studied the Suez problem and predicted that there will be a mass invasion of the Mediterranean by potentially disastrous species that may upset the whole ecology of this sea. He called it the 'Suez crisis of 1970'.

class	Pisces
order	Perciformes
family	Siganidae
genera	14 or more
species	<i>Siganus rivulatus</i>



Raccoon

Commonly known as 'coons', raccoons are one of the most familiar North American animals. If only in folklore and stories. Their adaptability has allowed them to withstand drastic changes in the countryside while their intelligence, cleverness and appealing looks have combined to make them popular. Their head and body length is 16–24 in. with a tail of 8–16 in. and they weigh up to 45 lb. Their fur is grey to black with black rings on the tail and a distinctive black 'burglar mask' over their eyes. Their feet have long toes and the front paws are almost hand-like and very dexterous.

Raccoons are relatives of pandas, kinkajous and coatis. There are seven species, the best known ranges from Canada to Central America. The crab-eating raccoon lives in southern Costa Rica, Panama and the northern regions of South America. The other species are found on islands.

Adaptable coons

Raccoons originally lived in woods and brushy country, usually near water, but as the woods have been cut down they have adapted to life in open country. They are solitary, each one living in a home range of about 4 acres, with a den in a hollow tree or in a rock crevice. They come out more at night, and are good climbers and swimmers. In the northern part of their range raccoons grow a thick coat and sleep through cold spells. The raccoons of southern USA and southwards, are active throughout the year. Where trees have been cut down raccoons move into fox burrows or barns and they have been known to spread into towns, even to the middle of cities where they live in attics and sheds and raid garbage bins for food.

Raiding garbage bins is one of the raccoon's less popular traits. Apart from the mess, the bins are sometimes carried away bodily. There are stories of ropes securing the bins being untied, rather than bitten through. This is evidence of the raccoon's extreme dexterity. They use their hands almost as skillfully as monkeys; experiments have shown that their sense of touch is very well developed.

Catholic diet

Raccoons eat a very wide variety of both plant and animal food. It is the ability to take so many kinds of food that is probably the secret of the raccoon's success and of its ability to survive changes in the countryside. Raccoons are primarily carnivores; earthworms, insects, frogs and other small creatures are included in their diet, and raccoons also search in swamps and streams for crayfish and along the shore for shellfish. The eggs and chicks of birds, both ground and tree, are sometimes eaten and raccoons are sometimes pests on poultry.

Just for fun. Two large bundles of fur—





© K. Schenck/Photo Disc



As an unsuspecting raccoon enjoys the shallow waters, unaware of the threatened danger of a cougar waiting for the moment to pounce.

♂ An imposing and rather formidable mother raccoon sits among the autumn leaves suckling her young. The cubs remain with their mother until they are about one year.

♀ A group of raccoons gather at the bank of a river, busy searching for food. Raccoons can both swim and climb very well and their diet includes shellfish, frogs, and birds' eggs.



farms and in waterfowl breeding grounds. They are also pests on agricultural land because they invade fields of corn, ripping off the ears and scattering them half-eaten. Fruits, berries and nuts are also eaten.

Irresponsible fathers

Raccoons mate in January or February, usually male mating with several females then leaving them to raise the family. The young, usually 3 or 4 in a litter, are born from April to June, after 60–70 days gestation. They weigh 2½ oz at birth and are clad in a coat of fuzzy fur, already bearing the characteristic black mask. Their eyes open in 18 days and at about 10 weeks they emerge from the nest for short trips with their mother. The trips get longer as the young learn to forage for themselves but they stay with their mother until about one year old. Raccoons live as long as 13 years.

Coon currency

Raccoons are a match for most predators and when hunted with dogs the raccoon may come off best, especially if it can lure the hound into water and drown it. Raccoons have always been trapped and hunted in large numbers by Indians and Europeans, both for their hard-wearing fur and because of their attacks on crops. Their fur was the main cause for killing them and even in the 17th century efforts were made by imposing taxes and bans to prevent too many raccoon pelts from being exported. At one time the skins were used as currency and when the frontiersmen of Tennessee set up the State of Franklin, the secretary to the governor received 500 coonskins a year while each member of the assembly drew three a day. Nowadays coonskin is not valuable unless there is a sudden fashion as there was for coonskin hats following the film on Davy Crockett. King of the Wild Frontier.

Why so fastidious?

In the *Systema Naturae* Linnaeus called the raccoon *Lutra (Lutra) Phocaena ferox* or the 'washing bear'. In other languages the raccoon is similarly named *ratons lavant*, *otlos lavadores* and *Washbären*. Their names testify to the strange habit raccoons have of appearing to wash their food before eating it. This apparently 'obsessive' behaviour has become part of the raccoon folklore and only recently have physiologists begun to study the behaviour.

Some books state that raccoons always wash their food, others say that the habit may be more common in captive animals, yet there are no authentic reports of food washing in the wild. Naturalists who have studied raccoons deny ever seeing this take place. Food washing must, therefore, be an unnatural habit of captive raccoons.

The first scientific study of food washing was made by Makolm Lyall-Watson at London Zoo. First, he showed that raccoons do not really wash their food but immerse it, manipulate it, then retrieve it. He suggested that the habit should, therefore, be called dousing.

Lyall-Watson gave a large variety of foods to a number of raccoons. Animal food was doused more often than plant, yet earth worms, the only food that needed cleaning were doused least of all. In another series of experiments it was shown that the shape, smell and size of food objects governed dousing to some extent, but most important was the distance of the food from water. The nearer the water, the more likely is food to be doused.

The conclusion drawn by Lyall-Watson explains why dousing only occurs in captivity. In the wild, raccoons feed on food found on land and food found in water. In captivity all their food is on land, so they

'go through the motions' of foraging in water by taking their food to water, dropping it, then searching for it in an 'empty' area. So-called 'washing' is such a commonplace that it is almost universal. When presented with food animals 'do' often throw them about and pounce on them, surrounding the food item.



class	Mammalia
order	Carnivora
family	Procyonidae
genus	<i>Procyon lotor</i>
& species	<i>North American raccoon</i> <i>P. cancrivorus</i> <i>crab-eater</i> , <i>coon</i> , <i>others</i>



Raccoon dog

Sleeping dogs?

In Europe they have taken to living in
ling up by day in dens under rocks, in
deserted burrows of foxes and badgers.

side passages and have even been known to
take up residence under occupied houses.
When nighting, raccoon dogs whine and
growl rather than bark. Each has a home
range of 3-4 acres, which varies in size,
depending on the seasonal food supply.

In the more northerly parts of their
range some raccoon dogs appear to hibern-
ate, but it is probably more correct to talk
of winter dormancy, as in bears, rather than
true hibernation. Local hunters say that
only well-fed raccoon dogs sleep for long
periods, lying on beds of grass and moss in
their burrows. These raccoon dogs emerge
on warm days, but the others that have not
accumulated a good store of fat spend the
winter hunting and only sleep through

Variable diet

The diet of raccoon dogs is very varied.
They eat plant foods such as fruit, roots,
acorns, grapes and grain. A wide variety
of animals is also eaten, but mainly insects
and small rodents such as voles and gerbils.
Other small mammals taken include hedge-
hogs, shrews and moles, and they also
feed on amphibians, including toads, birds,
especially groundnesters such as larks and
pheasants, fish, reptiles, molluscs and
carrion. Grass snakes are often eaten and
in southern parts of their introduced range
they eat young tortoises. Raccoon dogs also
scavenge among garbage.

The diet varies according to the time of
year. They concentrate on rodents in the
spring then take cockchafers and dung
beetles as they begin to appear towards the
end of spring. Birds and their eggs are
eaten in summer and berries and nuts
in the autumn.

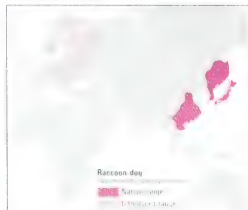
➤ In their natural habitat, two raccoon dogs
nose around a bamboo thicket in an Asian forest.





Scent marked territories

The breeding season starts in February or March when the male's 'yearning call' can be heard. The pair defend a joint territory, both marking it with urine like dogs. Gestation lasts 8 weeks and a litter of 6-8, up to 12, is born in the burrow. At first the young are blind and almost helpless. In three weeks their teeth erupt and one week later they can eat meat brought by the parents, although they still take their mother's milk. The young become independent in the autumn, but it seems that some families, including the father, stay together through the winter.



New European mammal

The raccoon dog has a valuable pelt and is now rare in Japan because it is hunted both for its skin and flesh. It has, however, been bred in captivity and the fur marketed as 'ussurian raccoon'. Raccoon dogs have been liberated in parts of Siberia and European Russia as a source of pelts since 1928. They have not done so well in Siberia where it is probably too cold but they have thrived in Russia, especially around Moscow, Leningrad, Kalinin, Smolensk and in the Priwet Marshes on the western border. From Russia, raccoon dogs have spread westwards. They are now found over most of Poland, also Hungary, Rumania and Czechoslovakia and are spreading into western Germany. They are also found in Finland and Sweden and are now invading Norway. The spread has been along rivers and will probably continue through western Europe, along the Oder and Elbe.

The introduction of a carnivore is usually detrimental, as with the mink in Britain, and the red fox in Australia, because they often severely affect the numbers of native animals. The raccoon dog does not seem to be a serious pest. It does not attack poultry but it could be a nuisance to pheasants and other game birds. One very real danger is that the raccoon dog is a carrier of rabies and other diseases. Attempts are being made to check the spread of rabies into Denmark, partly by controlling the red fox.

class	Mammalia
order	Carnivora
family	Canidae
genus	
& species	<i>Nyctereutes procyonoides</i>



John Tashjian at Fort Worth Zoo

Racer

Racers are closely related to whip snakes.

They have extremely muscular bodies with relatively large heads, small curved teeth, and large eyes. All racers are paler on the belly but, depending on the species, of which there are more than 20, they can be black, olive, brown or reddish on the back. Generally, racers living in humid areas are darker than those found in drier parts. The striped racer has a marked yellow stripe on its side. Black racers, the largest species, are often over 3½ ft long. The females are larger than the males. The young are usually brighter than the adults and are checkered with alternating blotches of pale olive and darker brown.

They are not poisonous or constrictor snakes but catch their prey by pressing it to the ground with their bodies.

Racers are found throughout most of the United States, Mexico, southern Europe, North Africa and southwest Asia.

Prefer open scrubland

Racers are usually found in scrubland, pastures or among crops, but the larger species also live in open woodland. They live on the ground but climb into bushes or trees, or even swim, to escape danger. They tend to remain 'homebased' all their lives, often not travelling out of an area of about 25 acres. Local movements may be made, for instance, escaping out of a crop at harvest time, or to find suitable places for hibernation.

They hibernate in crevices in rocks or in the disused burrows of pocket gophers or other animals. Sometimes they hibernate entwined in small groups with other snakes, not necessarily racers. They are usually found where the temperature is between 10 C/50 F and 0 C/32 F, but they can survive slightly lower temperatures for short periods. As much as 6 months may be spent in hibernation.

In the summer months racers control their body temperature by basking in the sun or seeking shade. They can tolerate a higher temperature than most other snakes and seem happiest in temperatures of around 26 C/79 F.

Eating according to size

Racers use eyesight to catch prey and they often course through dense cover in active search of food. Smell may also play a part as they are known to catch some animals in their burrows. When the prey is caught the racer works its jaws towards the head and swallows the animal whole, head first. The type of food eaten depends very largely on the size of the racer. Young snakes feed mainly on insects, lizards, frogs and grasshoppers but larger snakes will eat mice, voles, birds and other smaller snakes. Black racers eat mainly rats, weasels and young rabbits which they swallow whole. Racers are said also to eat the young of their own species but the only time EA Liner, who studied blue racers, actually saw this happen it almost seemed to be by mistake: two racers were attempting to swallow the same lizard. One succeeded and proceeded to swallow the other racer which was still clinging stubbornly to the lizard.

Promiscuous snakes

The courtship of the racer is like that of the garter snake (p 849). The male finds a receptive female in early spring and lies alongside



△ A united couple. Mating black racers, with their large heads and streamlined bodies, lie side by side in the grass, the male rippling spasmodically until mating is finished.

◁ The black racer is not all that its name implies. It moves at a maximum speed of $3\frac{1}{2}$ mph compared with 10 mph for a black mamba.

her, rippling spasmodically. The female sometimes moves off but this seems only to increase the male's interest. Two male racers may court the same female simultaneously. Racers lay eggs in clutches of 10–20. The number depends largely on the size of the female. The eggs are white and leathery and may be buried over a foot deep in an abandoned pocket gopher or ground squirrel hole, or, in humid climates, they may be near the surface just under some loose soil or a piece of wood. Development takes about 2 months and depends on the humidity and warmth of the environment. The young snakes usually hatch in August or September and break out of their eggs by means of an egg tooth which they lose a few days after hatching. The young are about 10 in. long and increase to about 17 in. before they hibernate in October.

Will fight if provoked

The natural enemies of racers are hawks, owls, skunks and other snake-eating snakes. The racer's eggs are very vulnerable, not only to predators, but also to drying out and flooding. The death rate among the first year young is again very high. Probably about 50% die in their first active year before they have reached mature size. Modern farming has reduced numbers drastically as farm machinery now moves too rapidly to permit escape and deep ploughing turns up racer eggs, while the cutting of crops forces many racers to seek new 'homes'. If disturbed a racer escapes as quickly as possible, zig-ragging silently away in the undergrowth often using a downhill slope to increase its speed. Sometimes it just coils itself passively and exudes musk or thrashes its tail excitedly to attract attention to a certain spot and then glides away quickly, often returning to the same spot by another route. It will also shed its tail, leaving it thrashing on the ground while the rest of the snake escapes. The racer sometimes puts up a spirited fight if cornered. It raises its head about a foot and strikes repeatedly at its enemy, lacerating the skin with its teeth.

Racer in name only?

It is commonly accepted that the racer is one of the swiftest of snakes and this is how it got its name. Yet the fastest reliable recorded speed for this same snake is only a little over $3\frac{1}{2}$ mph, no more than a good walking pace for a man. The speed of snakes is probably exaggerated because of the ease with which they slide through the undergrowth, disappearing in a trice. Compared with the black mamba (p. 138) whose maximum speed is 10 mph, the racer turns out to be not at all fast. Even the European grass snake (p. 934) can travel at 5 mph.

class	Reptilia
order	Squamata
suborder	Serpentes
family	Colubridae
genus	<i>Coluber constrictor constrictor</i>
& species	black racer
	<i>C. constrictor flaviventris</i>
	blue racer
	<i>C. flagellum piceus</i> red racer
	<i>C. lateralis</i> striped racer, others



1-15 CHALLENGERIA, 16-18 PHARYNGELLA, 19-20 ENTOCANNULA,

21-22 LITHOGROMIA

H. Ditzsch, Jena, Lithogr.

Plater, J. Göttingen

Radiolarian

Radiolaria are protists, single-celled animals remarkable for the beauty and complex structure of their minute skeletons, each one $\frac{1}{100}$ — $\frac{1}{5}$ in. across. They are all planktonic and marine, and when they die their siliceous skeletons sink down to the sea bed. In some parts of the world, particularly in the tropics, the ocean floor is covered for thousands of square miles by the ooze formed from the accumulation of radiolaria skeletons. The first complete account of these animals is in the three massive volumes compiled by the celebrated Ernst Haeckel, better known for his essays on the evolution of man. In these he illustrates, by exquisite drawings, hundreds of different kinds of radiolaria brought back by HMS Challenger from its voyage round the world in the 1870's.

The simplest radiolarian skeletons are latticework spheres with spikes radiating from the surface. Others are helmet shaped, or form complicated lattice systems. In the more complex of these there is a series of perforated spheres one inside the other, like the Chinese ivory balls, with dozens of spiny rays radiating from the centre, joining the spheres and projecting well beyond the surface of the outer sphere. In others there are only the radiating spines but the protoplasm clothing the inner parts of the rays is strengthened by numerous small siliceous spicules.

Far from simple protoplasm

The complicated and beautiful shells of radiolarians are built by a single cell. At the centre of each radiolarian is a horny capsule enclosing a large nucleus, sometimes a number of small nuclei. Immediately outside this capsule is a dark layer of protoplasm, surrounded by a thicker frothy layer. From the surface of this frothy protoplasm long delicate strands of protoplasm radiate outwards, projecting in all directions.

In the frothy protoplasm itself are many small yellow plants living in symbiosis with their host. The plants get shelter and also make use of the nitrogenous waste from the radiolarian. The latter profits from oxygen given out by the plants and in getting rid of its waste products. It is also possible that the radiolarian may digest a proportion of the plant cells.

How they rise and fall

Each radiating spine bears extremely minute strands, almost like infinitely small muscle fibres, which run to the surface of the frothy layer. When these shorten the

< Beautiful drawings of radiolarians brought back by HMS Challenger from its voyage round the world in the 1870's.

> Portrait of the artist as an old man. Ernst Haeckel, the 19th-century German scientist, drew some of the radiolaria with body organs which do not exist; his mistake was due to artefacts produced by laboratory stains.

> A true picture: living *Acanthometra* ($\times 195$) with spines of strontium sulphate.

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frothy mass is pulled outwards so it occupies a greater volume. As they relax the froth subsides, or is allowed to contract. By the changes in volume this layer acts as a hydrostatic organ, causing the radiolarian to rise or sink in the water. This is in addition to the large bubbles, or vesicles, in the froth, which are filled with water saturated with carbon dioxide makes the radiolarian float. When the water in these bubbles is expelled the radiolarian sinks. How these two processes work is not definitely known, nor is it certain whether the carbon dioxide in the bubbles is supplied by the symbiotic plants, although this seems likely. Nor is it known why radiolarians need to rise and sink in the water unless it be to avoid bright sunlight or rough water due to storms, or maybe it is a means of seeking a better food supply.

Floating 'fly traps'

If it should be proven that a radiolarian feeds on some of its plant guests, this would still form only a small part of its food. The normal feeding is by means of the slender radiating filaments. These are sticky and animals and plants far smaller than the radiolarians themselves bump against them and are caught. When one of these is caught by a filament another filament bends towards it to complete the trap. The food item is then carried by a streaming of the protoplasm to the dark mass surrounding the central horny capsule where it is digested.

Over-enthusiastic

The German scientist, Ernst Haeckel, belongs to the mid-19th century, to the time when the scientific world was still hotly debating Darwin's theory of evolution by natural selection. Haeckel seized on this with enthusiasm and threw himself wholeheartedly into the search for evidence to support Darwin's view. He seems to have been a man of outstanding energy and application, and above all he was a superb artist. He had, however, an outstanding fault and while it may seem ungenerous to draw attention to it, in view of his other achievements, it does serve as a lesson. In his enthusiasm he was apt to see evidence that did not exist. It is a very human fault, but Haeckel had it, perhaps above-average, so much so that his contemporaries, and those that succeeded them, described it as 'haeckelism'—the tendency to support a theory by dubious facts. So far as Haeckel himself is concerned this failing is unfortunately never evident in his otherwise superb monograph on the radiolaria. In some of his pictures he has drawn what purport to be organs in the body of the radiolarian. Examination of the specimens from which he made his drawings shows clearly these are no more than artefacts due to the laboratory stains he used.

phylum	Protozoa
order	Radiolaria

Fig. 101 Sphaerocoum mag. Sphaerocoum, which lives in colonies, floats in the plankton by aid of bubbles in its contractile spaces. (591)

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